Plant Archives Vol. 19, Supplement 2, 2019 pp. 11-18 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

GROWTH AND NITROGEN USING EFFICIENCY FOR SEVERAL GENOTYPES OF MAIZE (*ZEA MAYS* L.)

Jawad, A.H.[1,2] and Laila, I.M.[1]

[1]College of Agricultural, Engineering Sciences, University of Baghdad, Iraq

[2]College of Agriculture, University of Wasit, Iraq

Corresponding author: dr.layla.almajidy@gmail.com

Abstract

The research was carried out in the fields of research station in the College of Agricultural Engineering Sciences, University of Baghdad, Jadriya and College of Agriculture fields, Wasit University, during autumn 2017 and spring 2018 seasons, to study the growth and nitrogen using efficiency of six inbred lines of yellow maize and their crosses, with the high yield, in the autumn season of 2017. The inbred lines (Zin 11, Zin6, Zin9, Zin8, Zin4 and Zin19) were inserted in a one-way crossing program according to the second method of (Griffing, 1956b) in the spring season of 2018. The Randomized Complete Block Design (RCBD) was used in order to arrange the split plots with four replicates, The main plots included nitrogen fertilization levels of 120, 220 and 320 Kg N.ha^{-1}, while the sub-plots included 22 genotypes, six inbred lines and their fifteen odd crosses, as well as al-phrates comparison genotype for both sites. The results showed significant differences between the levels of nitrogen fertilization of all the studied traits, except for the number of days up to male flowering, the fertilization level (320 Kg Nha^{-1}) gave the highest leaves area (5347 and 4552 cm^2), plant height (202 and 178 cm), ear height (123 and 101 cm) and grain yield (123 and 106 g plant^{-1}) for both Baghdad and Wasit sites respectively. There were also significant differences between the genotypes, the inbred line crosses 2 were superiority in most of the studied traits at both sites, including cross (2x5) with an earlier male flowering by (65.0 and 64.1 days) and the highest leaves area (7673 and 4862 cm^2) and plant height (237 and 195 cm), ear height (143 and 113 cm), grain yield (225 and 159 g plant^{-1}) and e NUE (64.72 and 49.06%) for both sites respectively. Finally, the hybridization process was efficient in the yellow maize, there were crosses that superior to the highest inbred lines in growth and yield traits as well as the efficiency using of nitrogen.

***Keywords*:** Number of days up to male flowering, Diallel crossing, grain yield.

Introduction

The using efficiency of nitrogen was influenced by the complex interaction between several physiological processes, which include nitrogen absorption from the soil and the amino acids' ability to transfer nitrogen from source tissues to sinks at all stages of plant development, especially during the period of grain filling. In addition to that, the role of directives and streamlining that integrate the nitrogen plant condition and its growth (Moose and Below, 2009). These findings were confirmed by radioactive isotopes (N^{15}) study, which 38% of the nitrogen added to the soil can reach the crop in the best case (Dixon, 2003), indicating that more than half of the nitrogen fertilizers that used in the production of maize lost to the surrounding plant environment. In 2014, Bodirsky *et al*. found that the planting contributes in rising of soil, water, and atmosphere pollution with nitrogen due to the irrational use of nitrogen fertilizers. Pollution is expected to reach by 2050 to 102-156% of its value in 2010 and to make pollution levels below the critical limits while maintaining food security, the improvement of Nitrogen Using Efficiency (NUE) in agricultural production was considered as the most important design option. The best additional amount of nitrogen fertilizer represented by optimal productivity in both quantity and quality with preserving the environment (Ali, 2012). The definition of (NUE) depend to the purpose that planned, Field and measured recovery efficiency were appropriate performance indicators, especially in the selection of more efficient genotypes to absorption nutrient or nutrient transport assessment among soil populations (Norton *et al*., 2015). Several mechanisms control the flowering process that was connected with a large number of genes as well as the act of genes couples that governing the trait. Thus, the number of days from planting to male flowering in yellow maize varies according to genotypes and environmental conditions (Tollenaar *et al*., 2004). Usually, this variation became more clearly under stresses, including critical nitrogen stress (Moose and Below, 2009). Al-Daoudi *et al*., 2015 obtained a significant differences between nitrogen levels (300, 350 and 400 kg urea ha^{-1}) in the number of days of planting and up to 50% male flowering, while (Gozubenli and Konuskan, 2010) indicated that there were no significant differences between male flowering periods under four levels of nitrogen fertilizer and four plant densities when testing one of the genotypes from the yellow maize. A few physical and functional differences were appeared when the maize plants growing under nitrogen stress conditions, such as low plant height and reduced leaves area, Which may be reflected in the plant yield decreasing (Muchow and Sinclair, 1994). Wuhiab *et al*., 2016 indicated that the leaves production area was different between daillel and reciprocal crosses, the daillel cross (2×1) achieved the highest leaves area and the Father (1) gave the highest leaves area among other fathers. While (EL-Meksen and Badawy, 2015) found in their study that, although some crosses gave a high yield, But they didn't achieved a significant difference in plant height, ear height and grain yield traits with adding rate of 214 kg N/ h compared with 321 kg N/h. (Bello *et al*., 2012) found significant differences in ear mean height when comparing ten genotypes of maize. Finally, The aim of the research was to investigated the effect of genotypes on nitrogen efficiency, total growth, and yield under different levels of nitrogen concentration.

Materials and Methods

The research was carried out in the fields of research station in the College of Agricultural Engineering Sciences - University of Baghdad, Jadriya and College of Agriculture fields, Wasit University, during autumn 2017 and spring 2018 seasons, to study the growth and nitrogen efficiency of

six inbred lines of yellow maize and their crosses, Seeds were obtained from the Department of Field Crops symbolized as (Zin 11, Zin6, Zin9, Zin8, Zin4 and Zin19) then, numbered as 1, 2, 3, 4, 5 and 6 respectively. In the crossing program, seeds were planted after three days from calibration irrigating with two seeds in gore, diluted to one plant after two weeks of germinate. Nitrogen was added at a rate of 250 Kg N.ha^{-1} in the form of urea $(NH_2)_2CO$ (N%46) over two steps, at planting and the second after one and a half months of planting, except for the comparison experiment in case of Nitrogen quantity. Phosphorus was added with a rate of 100 KgP_2O_5.ha^{-1} in the form of common phosphate fertilizers, Furthermore, Potassium added in the comparison experiment at a rate of 100 KgK_2Oha^{-1} in the form of Potassium sulfate (K_2SO_4 (K_2O 50%) in planting, (Ali, 2012). The program of election, inbred lines proliferation, crossing, and assessment was carried out according to agricultural seasons, during autumn season, six lines were crossed, three of which had relatively high nitrogen content compared to the other three with lower content were planted on 1/8/2017 in the field of college of Agriculture, Wasit University. These lines were inserted in a one-way crossing program according to the second method of (Griffing 1956b). At the flowering stage, the female inflorescences were encased before the silk germination with small paper bags to prevent the cross-pollination. While the Tassel inflorescences were packed with large paper bags a day before the start of the pollination process, after launched the pollen at next day, the silk germination was vaccinate to receive pollen, in the same way, it was possible to make the required vaccinations between the six inbred lines and the self- vaccination of the inbred lines. At maturity, the resulting crossing ears were harvested and dried and laying it individually for planting in the next season. In 2018, during the spring season, the comparison experiment was carried out in the same locations that mentioned previously at 20/3/2018 and 21/3/2018 for Baghdad and Wasit field respectively. The experiment field area was dived by 2.6 m furrows length, with one furrow for each genotype at 0.85 m between them and 0.2 m between each gore as an intensity of 59000 plant.ha^{-1} . The Randomized Complete Block Design RCBD was used in order to arrange the split plots with four replicates (the fourth replicate data was eliminated due to the huge variation of the soil filed). The main plots included nitrogen fertilization levels of 120, 220 and 320 Kg N.ha^{-1}, taking into account the amount of ready nitrogen in the soil. while the sub-plots included 22 genotypes, the six inbred lines and their fifteen odd crosses, as well as al-phrates comparison for both location. Several traits were studied in this research such, the number of planting days up to 50% of the male flowering, leaves area (cm^2), height of the plant (cm), the main ear height (cm), the grain yield of the plant(g) and the Nitrogen using efficiency (NUE). The NUE was calculated according to the following equation (Moll *et al*., 1982)

NUE = Gw – Ns

Gw: Dry Grain Weight (grain yield).

Ns: Nitrogen supply (adding+ existing soil) expressed in units similar to yield units (g. / plant) .

The variance analysis of the studied traits was performed according to the RCBD the split plot . The mean values of traits were tested using the least significant difference (LS D). at the 5% probability level

Results and Discussion

Number of days up to 50% of male flowering (day) trait

The variation analysis results and means values for the number of male flowering showed that there was no significant difference in the levels of nitrogen fertilization (N120, N220 and N320) for this trait. While The genotypes achieved a significant difference, the inbred lines 3 recorded the lowest number of days with 65 days for both sites, significantly higher than the rest of the inbred lines in the Baghdad site, while not significantly different from lines 1, 2 and 5 in Wasit site. the inbred line 4 spent the longest duration with a 71 and 68 day for sites, respectively. The resulting crosses showed that 8 crosses were superior on the general mean of the trait in both location, while 11, 15 crosses were superior on the comparison class which spent 68, 69 days up to 50% of male flowering for Baghdad and Wasit sites respectively. Noting that all the crosses of inbred line 2 was earlier in the male flowering and did not significantly different between them and (3x5) cross in both sites. The study finding according to Table 1 showed a significant differences in the interface between genotypes and levels of fertilization, as well as the superiority of 13 genotypes significantly on the general average of the trait at N-320 level and 10 and 11 at N-220 level, while 12 and 8 was superior at the level of N-120 both locations respectively. The crosses results that obtained from the use of inbred 2 as mother (4 × 2, 5 × 2 and 6 × 2) showed an earlier male flowering r under the three fertilization levels. As it took the average of 65 and 64 days for the Baghdad and Wasit locations respectively. This behavior resulted from the role of mother inheritance in the male flowering trait. The phenotypic changes associated with cytoplasm changed, and are often larger than those in single nuclear locations (Clarke, 2013).

Leaves area (cm^2) trait

The fertilization levels had a significant effect on the average leaves area, the increase in the fertilization level from 120 to 320 kg was accompanied by a significant increase in the leaves area from 5163 and 4349 cm^2 to 5357 and 4552 cm^2 for both sites respectively as shown in Table 2. This increment refers to the role of nitrogen in increasing the leaves area and its effectiveness in the abundance of other growth factors, which present a good agreement with (Abd and Abd, 2010) findings that " high nitrogen stress causes a lack of leave area, resulting in low light resistance and low representation of vegetal perfusion. The results showed that there were significant differences between the genotypes, noting that the inbred line 4 was a significant superiority for the rest of inbred lines and the comparison class, and gave 20% more than the general mean (5279 cm^2) in the Baghdad site.

The superiority of inbred 4 in leaves area trait might be due to the period of planting length up to 50% male flowering as shown in Table 1, although from deteriorating the growth trait, and other yields or according to the field observations and the measurement equation used, inbred line 4 gave a long leaf but thin and yellow as there is a severe lack of ability in plant photosynthesis from the way to speed up the leaves aging. This behavior was explained by (Hefny, Aly 2008) which indicated that the leaves of the inbred lines are less greener than the crosses leaves when they grow under low level of. The inbred 3 was a significant superiority

over comparison class, general mean, and the rest of the inbred lines in Wasit site with an average leaves area amounted to 4845 cm^2, while the inbred line 5 was recorded the lowest value of (4203 cm^2) and was significantly lower than the rest of the inbred lines in Baghdad. Furthermore, the inbred 6 had given the lowest leaves area (3978 cm^2) and did not significantly different from the 2 and 5 lines in Wasit site. The crosses results showed that, 6 and 5 crosses in both sites had superiority on the general mean, The highest leaves area mean was 7073 cm^2 for (5 × 2), which was significant superiority than the other genotypes mean and the general mean for this trait of in Baghdad site. However, it was not significantly different from the crosses results of using the inbred line 2 as mother in Wasit site, the lowest mean leaves area was recorded by 4327 cm^2 for the cross (6 × 1) in the Baghdad site, and 4100 cm^2 for the cross (6 × 3) in the Wasit site. In general, a reduction was occurred by 17.78% in the overall mean trait value of Wasit sites compared to Baghdad. The study findings that listed in Table 2 showed the genotype behaviors differed through the nitrogen fertilization treatments. Thus, the cross (5x2) gave the highest leaves area amounted to 7372 cm^2 which was the same area at N-320 level and significantly different than the other N-220 and N-120 levels at Baghdad site. while the results show the difference was closely approximate as cross (4 × 2) gave with N-120 level the highest leaves area by 5212 cm^2, and did not significantly different from 8 and 5 genotypes at N-320 and N-220, respectively. As not a significantly different from the two crosses (3 × 2) and (6 × 2) below the additional level (120N) itself. The increase in nitrogen fertilizer leads to an increase in leaves area (Dulaimi, 2006 and Al-Ain, 2010).

Plant Height Trait

The increase in fertilization levels was accompanied by a significant increase in the plant height, By increasing the fertilization level from 120 to 320 Kg Nha^{-1} the average plant height increased from 194 and 168 cm to 202 and 178 cm for both sites as shown in Table 3, this increase may indicate that plants use nitrogen during the cell effective division and to synthase the necessary protein to the cells expand and thus increase plant height (Ali and Anjum, 2017). The inbred lines 3 was significant superiority on the rest of the inbred lines and the comparison class and the general mean for this trait with an average height reached to 214 and 179 cm for both sites respectively, but did not significantly different from inbred 1 in Wasit site, which the average height was reached 180 cm, while the inbred 2 was the shortest (163 and 152 cm respectively for both sites. The decline in the inbred lined plant's height was confirmed by the results of (Said and Pectash, 20 10) and (Dona et al., 2012), noting that the decline might be due to the concentration of pairs genes to the plant height trait during the self-pollination of previous seasons. The crosses results showed that (8 and 10) and (11 and 13) crosses had superiority on the general mean trait and comparison class for both sites respectively. The highest cross was (2 × 5) ,which gave the average plant height 237 and 195 cm in both sites, respectively, and significantly higher on all the crosses, lines, comparison class and the overall mean, but it did not a significantly different from the cross (2 × 3) in Wasit, while (4 × 5) cross gave the lowest average plant height was 169 and 153 cm and both sites, respectively, and did not a significantly different from the cross (4 × 6) in Wasit site. The wide range in the plant height between the genotypes reflects the genetic differences between them, noting that 5 crosses superiority on the highest lines in Baghdad site, while one cross in the Wasit site. In general, a decline was occurred in all genotypes by 13.85% in the overall mean trait value of Wasit site compared to Baghdad, This may be due to the environmental condition from edaphic, temperature and relative humidity, or to genetic factors related to the gene performance in the environment, and reflected the genetic interchanged between the inbred lines on their crosses or a physiological performance of the genotypes by internodes elongation due to Auxins resulted from the genotypes shading on each other and the lack of access light to the plant parts appropriately (Sarjamei et al., 2014, Balem et al., 2014). The interface between fertilization level and genotype that describe in Table 9 was caused a difference in the quantity and direction of the plant response, the average plant height for the genotypes was different when the fertilization level increased.

The cross (5 × 2) recorded a constant mean for plant height at N-120 and N-220 by 235 cm and increased to 242 cm at N-320 in Baghdad, The same behavior for same cross was repeated in Wasit site with height of 209 cm at N-320. While cross (5 × 4), which was characterized by a limited plant length had a gradual increasing from nitrogen levels N-120 to N-320, indicating its response to nitrogen fertilization despite its shortness. The interference result were also indicated that 9 genotypes (2 inbred and 7 crosses) and 13 (3 inbred and 10 crosses) at N-320 the Baghdad site, 13 genotypes (3 inbred and 10 crosses) had the superior over the general men and comparison class at both sites respectively. while 7 genotypes superiority in both sites, At level N-220. And at N-120 was present lowest result, with 7 and 3 genotypes in both sites had the superiority, respectively as shown in Table 3.

The Ear Height (cm) Trait

The results showed that the fertilization levels had a significant effect on the average ear height, when the fertilization level increased from 120 to 320 kgNha^{-1}, the average height of the main ear increased from 118 and 94 cm to 123 and 101 cm for both sites (Baghdad and Wasit) respectively. The ear height was affected by the plant height which is affected by the factors responsible for internodes elongation of plant, including nitrogen. The study finding that related to the increasing and decreasing of the average ear presented a good agreement with the results of plant height trait that listed Table 3. The inbred lines 3 was significant superiority on the rest of the inbred lines and the comparison class and the general mean for this trait with except the inbred lines 5 and 1 with average height reached to 130 and 107 cm for both sites respectively, while the inbred lines 2 was recorded the lowest value for this trait with (96 and 81 cm) respectively for both sites. The crosses results showed that (6 and 8)) crosses had superiority on the general mean trait and 13 crosses had superiority on the comparison class in both sites respectively. The highest cross was (2 × 5) , which gave the average ear height with 143and 113 cm in both sites, respectively, and significantly higher overall genotypes and the general mean, but it did not a significantly different from the cross (2 × 3) in Wasit, while (4 × 5) cross gave the lowest average ear height with 87 and 73 cm and both sites, respectively, and did not a significantly different from the cross (4 × 6) in Wasit site. The wide range in the ear height between the genotypes reflects the genetic

differences between them, noting that4 crosses had the superiority on the highest lines in Baghdad site, while 2 crosses in the Wasit site.

In general, a decline was occurred in all genotypes by 23.71% in the overall mean trait value of Wasit site compared to Baghdad. The results indicated that there was a significant interface between levels of nitrogen fertilization and genotypes in the average ear height as shown in Table 4, indicating that the behavior of the genotypes differed through nitrogen fertilization treatments. The average ear height was a significant different for cross (6 x 2) when the fertilization level increased with an 148 average height at the N-320 level, and not different from the cross (5 x 2) that present constant behavior as (144 cm for each N-120 and N320 levels) when fertilization levels changed. This was in Baghdad site, while in Wasit site the cross (5 × 2) was a significant superiority with the fertilization levels increased from N120 to N320, significantly on the other Interactions as shown in Table 4. The different genotypes among them in the ear height trait has been supported by many studies in this filed such (Ahmad *et al*., 2011 and Bello *et al*., 2012).

Rain Yield (g / plant) Trait

Grain yield was Algebraic function for its component (number of ear in plant, number of ear grain, and grain weight), therefore The results of Table 5 vary according to the ability of the genotype to nitrogen using efficiency to increase the ears origin or the number of fertilized seeds or increase the weight of the grain by transferring the supplement from sources to sinks in the period of grain filling. The results that listed in Table 33 showed that the levels of fertilization had a significant effect on the average grain yield. the average grain yield was increased from 96 and 83 g. plant^{-1} to 112 and 98 g. plant^{-1} at the level of N-220 and 123 and 106 g. plant $^{-1}$ the level of N-320 for both sites (Baghdad and Wasit) sequentially. The inbred lines 3 was significant superiority on the rest of the inbred lines and the comparison class and the general mean for this trait 1 with average yield reached 153 and 126 g. plant $^{-1}$for both locations respectively, while the inbred lines 2 was recorded the lowest value for this trait with 33 and 35 g. plant^{-1} respectively for both locations. The crosses results showed that (6 and 8) crosses had superiority on the general mean trait and (12 and 11) cross had superiority on the comparison class in both locations respectively. The highest cross was (2 × 5) ,which gave the average grain yield with 212 g/ plant in Baghdad location, and significantly higher than overall crosses, inbred lines, comparison class and the general mean, while the (2× 4) cross gave the highest average grain yield by 169 g/ plant in Wasit sites, while (4 × 5) cross gave the lowest average grain yield at both sites and did not a significantly different from the cross (4 × 5) which the inbred line 4 was the mother as shown in Table 5. A similar result was obtained from the studying of number of ear trait, which indicates the contribution of the number of ears to the plant Give a superior grain yield

Nitrogen Use Efficiency trait

There was a significant difference in fertilization levels as shown in Table 6, the highest one was (47.35%, 40.78% for both sites) respectively in level N-120 and the lowest by (22.69% and 19.5%) for both locations in level N-320, respectively. The NUE decreases and the risk of loss to soil systems increases, with increasing rates of addition (Chakwizira et al., 2016). Due to the large variation in nitrogen levels relative to the change in the amount nitrogen absorbed. The inbred lines 3 was significantly superiority to the rest of the inbred lines and the general mean for this trait 1 with percentage reached 47.32% and 38.63% for both locations respectively, while the inbred lines 4 was recorded the lowest percentage by 10.32% and 11.06% respectively for both sites. The crosses results showed that (9 and 8) crosses had significant superiority on the general mean trait and (12 and 11) cross had superiority on the comparison class which gave the highest rate by (in both sites respectively. The highest cross was (2 × 5) ,which gave the average nitrogen level with 64.72% in Baghdad site and by 52.47% in Wasit site which significantly higher than other genotypes, as a result of their superiority in most yield and growth, Agrees with (Bubert (2014) that increasing nitrogen efficiency was aimed at improving maize production in the future , while (4 × 6) cross gave the lowest NUE of all crosses by average 13.0.2% and 11.83 at both locations and did not a significantly different from the cross (4 × 5). It is noted from the above results that strain 4 and the combinations in which it participated as a mother was the lowest in the efficiency of the use of nitrogen. In (4 × 2) cross, which was the inbred line 4 as a father, showed superiority to the study sites. This confirms the role of the inbred line 2-as a mother, which gave all its crosses a high mean, indicating the effect of cytoplasmic inheritance in showing the plant's ability to use nitrogen efficiently. It is noted that the mixing (2x5) showed high performance at all levels of nitrogen fertilizing, The increasing percentage was 98.9%, 95.5% and 82.9% at 120, 220 and N-320 respectively in the grain yield at compared to the general average of each level of nitrogen (120 kg N ha^{-1}). This indicates high susceptibility For this cross to use the Nitrogen in the yield production, and thus increase the efficiency of the use of nitrogen. The interface between fertilization level and genotype in NUE that describe in Table 3 was indicating a difference in the quantity and not the direction of the response. The cross (5 × 2) gave a mean by a 93.94%, 58.75% and 41.47% at N-120, N-220 and N-320 levels of fertilization, superior on other cross in Baghdad site. In the Wasit site,(4x2 was the highest value of 78.90% and 47.65% at the N-120 and N-220 levels respectively, but did not significantly outweigh the 3x2 distortion at the N220 level and gave the 3x2 with a rate of 31.33% at the N320 level in Wasit, similar to those involving the 2-strain (3 × 2), (4 × 2), (5 × 2) and (6 × 2) level of 320 Kg N / ha. From the above result, the response of the different genotypes differed between them and with different levels of nitrogen fertilization, there were crosses that were superior to the highest inbred lines in growth and yield traits as well as the efficiency using of nitrogen .

Table 1 : Average number of days of planting up to 50% male flowering (day) to the genotypes of maize under nitrogen levels on the study location**.**

Genotypes	Baghdad site				Wasit site			
	Nitrogen levels Kg N. E-1			Mean	Nitrogen levels Kg N. E-1			Mean
	120	220	320		**120**	**220**	**320**	
1	66.0	65.7	65.7	65.8	65.7	66.3	64.7	65.6
2 × 1	67.0	66.7	66.3	66.7	67.3	66.7	65.3	66.4
3 × 1	67.0	67.3	66.3	66.9	65.3	65.3	66.0	65.7
4 × 1	66.7	66.3	66.3	66.4	66.0	67.3	67.0	66.8
5 × 1	66.3	67.0	68.7	67.3	66.3	65.0	65.0	65.4
6 × 1	66.3	65.7	65.3	66.8	64.7	64.3	63.7	64.2
2	65.3	68.0	66.7	66.3	67.0	64.7	63.7	65.1
3 × 2	65.0	65.0	65.0	65.0	66.3	64.0	63.7	65.0
4 × 2	65.0	65.3	65.3	65.2	63.3	64.3	65.3	64.3
5 × 2	65.0	65.0	65.0	65.0	64.0	64.3	64.0	64.1
6 × 2	65.0	65.0	65.0	65.0	64.3	63.3	63.3	63.8
3	65.7	65.3	65.0	65.3	65.3	64.7	64.0	64.7
4 × 3	66.7	68.7	69.0	68.1	66.7	67.3	68.0	67.3
5 × 3	65.0	65.3	65.0	65.1	64.3	64.3	63.3	64.0
6 × 3	67.0	67.0	67.0	67.0	66.0	66.3	66.3	66.2
4	72.0	70.3	72.0	71.4	67.3	67.3	70.0	68.2
5 × 4	67.7	68.0	67.7	67.8	67.7	67.3	68.0	67.7
6 × 4	68.0	68.3	69.0	68.4	68.3	67.3	67.7	68.8
5	65.7	67.3	66.7	66.6	65.7	64.3	65.3	65.1
6 × 5	66.0	65.3	65.0	65.4	64.3	65.7	65.0	65.0
6	66.7	67.7	66.0	66.8	66.0	67.3	68.0	67.1
Comparative class	67.7	67.7	68.0	67.8	69.0	68.7	68.0	68.6
A. F. M. 5%	1.27			0.74	1.67			0.93
	66.50	66.73	66.64	66.62	65.96	65.74	65.70	65.80
A. F. M. 5%	**n. s.**				**n. s.**			

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Table 2 : Average leaves area (cm^2) for genotypes in maize under nitrogen levels and for study location.

Genotypes	**Location of Baghdad**				**Location of Wasit**			
	Nitrogen levels kg N. E-1			Average	Nitrogen levels kg N. E-1			Average
	120	220	320		**120**	**220**	**320**	
1	4528	4811	4409	4583	4298	3853	4768	4306
2 × 1	4944	4905	4509	4786	4127	4864	4741	4577
3 × 1	4289	4843	4492	4541	4371	4647	4665	4561
4 × 1	4733	4795	4604	4711	4663	4645	5004	4771
5 × 1	4339	4510	4396	4415	4035	4676	5045	4585
6 × 1	4503	4169	4310	4327	4225	5106	4315	4549
2	5137	4468	4770	4792	3980	4419	4034	4144
3 × 2	5816	5926	6356	6033	4903	4906	5046	4952
4 × 2	5329	6150	5821	5767	5212	5169	4881	5087
5 × 2	6780	7067	7372	7073	4724	4710	5152	4862
6 × 2	4834	5145	5742	5240	5024	5088	4763	4958
3	5829	5901	6083	5938	4566	5003	4966	4845
4 × 3	4758	5271	5490	5173	4642	4185	4412	4413
5 × 3	5895	6185	6108	6063	4333	4145	4508	4329
6 × 3	5630	5669	5583	5627	3835	4227	4238	4100
4	5962	6465	6661	6363	3999	4390	4626	4338
5 × 4	5617	5860	5548	5675	3664	4410	4435	4170
6 × 4	5642	5345	5320	5436	4058	4510	3999	4189
5	4140	4138	4332	4203	4279	3998	3836	4038
6 × 5	4893	5054	5010	4986	4348	4469	5129	4649
6	4486	4742	4828	4685	4296	3926	3712	3978
Comparative class	5511	5575	6105	5730	4091	4623	3871	4195
A. F. M. 5%	**588**			**345**	**487**			**284**
	5163	**5318**	**5357**	**5279**	**4349**	**4544**	**4552**	**4482**
A. F. M. 5%	100				112			

Table 3 : Average plant height (cm) for genotypes in maize under nitrogen levels and for study location.

Genotypes	Location of Baghdad				Location of Wasit			
	Nitrogen levels kg N. E-1			Average	Nitrogen levels kg N. E-1			Average
	120	220	320		120	220	320	
1	171	177	178	175	178	178	184	180
2 × 1	194	197	201	198	171	176	181	176
3 × 1	168	180	180	176	173	176	185	178
4 × 1	193	191	194	192	176	174	183	178
5 × 1	189	187	196	191	166	166	176	169
6 × 1	193	196	201	197	184	184	186	185
2	161	162	165	163	141	155	160	152
3 × 2	215	218	230	221	193	191	208	197
4 × 2	204	223	217	215	174	182	186	180
5 × 2	235	235	242	237	188	188	209	195
6 × 2	210	222	229	221	175	181	184	180
3	213	209	219	214	176	178	183	179
4 × 3	194	193	196	194	162	168	174	168
5 × 3	223	227	231	227	178	186	182	182
6 × 3	187	196	208	197	170	176	172	173
4	182	184	184	183	160	163	164	163
5 × 4	167	168	171	169	140	159	160	153
6 × 4	173	173	183	176	150	158	156	154
5	210	203	207	207	166	178	182	175
6 × 5	220	228	232	227	174	183	187	181
6	179	178	181	179	151	149	150	150
Comparative class	177	181	202	187	154	161	166	160
A. F. M. 5%		9		5		5		3
	194	197	202	197	168	173	178	**173**
A. F. M. 5%		**5**				**2**		

Table 4 : Average ear height (cm) for genotypes in maize under nitrogen levels for study location.

Genotypes	Location of Baghdad				Location of Wasit			
	Nitrogen levels kg N. E-1			Average	Nitrogen levels kg N. E-1			Average
	120	220	320		120	220	320	
1	108	108	111	109	103	101	110	105
2 × 1	125	124	135	128	89	97	105	97
3 × 1	105	108	111	108	98	102	102	101
4 × 1	121	122	129	124	105	101	113	106
5 × 1	123	120	127	123	94	90	102	95
6 × 1	120	126	121	122	107	108	105	107
2	100	94	94	96	78	82	83	81
3 × 2	130	130	131	130	109	107	117	111
4 × 2	126	137	131	131	103	101	112	106
5 × 2	144	141	144	143	105	111	124	113
6 × 2	127	136	148	137	106	107	108	107
3	126	128	130	128	104	103	113	107
4 × 3	122	122	120	121	98	99	105	100
5 × 3	137	132	143	137	99	113	108	106
6 × 3	113	120	119	117	86	93	83	87
4	110	113	111	111	89	86	82	86
5 × 4	90	81	89	87	67	78	76	73
6 × 4	98	94	100	97	74	76	75	75
5	130	131	131	131	87	109	111	102
6 × 5	127	135	141	134	99	106	107	104
6	122	121	128	123	85	84	81	83
Comparative class	98	101	109	103	78	81	91	83
A. F. M. 5%		**8**		**4**		**5**		**3**
	118	**119**	**123**	120	**94**	**97**	**101**	97
A. F. M. 5%		**4**				**2**		

Table 5: Average grain yield (g / plant) for genomic structures of maize under levels of nitrogen and for study sites.

Genotypes	Location of Baghdad				Location of Wasit			
	Nitrogen levels kg N. E-1			Average	Nitrogen levels kg N. E-1			Average
	120	220	320		**120**	**220**	**320**	
1	73	86	96	85	80	88	99	89
2 × 1	90	127	120	112	69	99	109	92
3 × 1	76	87	116	93	90	113	135	113
4 × 1	123	125	140	129	86	100	104	97
5 × 1	130	123	144	132	56	58	81	65
6 × 1	103	119	134	119	105	121	139	122
2	84	88	108	94	49	60	84	64
3 × 2	147	169	171	162	110	168	170	149
4 × 2	161	196	195	184	160	178	167	169
5 × 2	191	219	225	212	149	161	167	159
6 × 2	140	167	182	163	134	127	155	139
3	144	155	161	153	117	127	133	126
4 × 3	52	75	98	75	58	69	78	68
5 × 3	142	193	191	176	126	145	146	139
6 × 3	75	86	104	88	72	82	90	81
4	31	33	34	33	35	33	38	35
5 × 4	47	43	49	47	37	40	49	42
6 × 4	34	46	53	45	29	46	41	39
5	40	42	52	45	43	53	55	50
6 × 5	118	138	161	139	117	155	148	140
6	51	73	83	69	52	57	56	55
Comparative class	64	74	89	76	51	74	84	70
A. F. M. 5%		**12**		**7**		**11**		**7**
	96	**112**	**123**	110	**83**	**98**	**106**	96
A. F. M. 5%		4				2		

Table 6 : Average nitrogen use efficiency (NUE) for genomic structures of maize under levels of nitrogen and for study sites.

Genotypes	Location of Baghdad				Location of Wasit			
	Nitrogen levels kg N. E-1			Average	Nitrogen levels kg N. E-1			Average
	120	220	320		**120**	**220**	**320**	
1	35.86	23.05	17.72	**25.54**	**39.20**	**23.47**	**18.20**	26.96
2 × 1	**44.41**	34.04	22.04	33.50	33.70	26.42	20.06	26.73
3 × 1	37.56	23.39	21.44	27.46	44.12	30.41	24.88	33.14
4 × 1	60.51	33.54	25.85	39.97	42.22	26.75	19.16	29.38
5 × 1	63.92	32.90	26.55	41.12	27.63	15.52	14.85	19.33
6 × 1	50.61	31.93	24.73	35.76	51.69	32.41	25.66	36.59
2	41.43	23.67	19.99	28.36	24.16	16.22	14.41	18.60
3 × 2	72.41	45.41	31.47	49.76	53.85	44.97	31.33	43.38
4 × 2	79.26	52.44	35.92	55.87	78.90	47.65	30.88	52.47
5 × 2	93.94	58.75	41.47	64.72	73.32	43.09	30.75	49.06
6 × 2	69.00	44.80	33.59	49.13	65.88	33.99	28.55	42.81
3	70.93	41.44	29.60	47.32	57.30	34.15	24.46	38.63
4 × 3	25.57	19.99	18.14	21.23	28.45	18.58	14.33	20.45
5 × 3	69.82	51.87	35.26	52.32	61.75	38.99	26.96	42.57
6 × 3	36.65	22.99	19.16	26.27	35.40	21.99	16.63	24.67
4	15.44	8.90	6.34	10.32	17.37	8.85	6.96	11.06
5 × 4	23.14	11.66	9.07	14.62	18.32	10.66	9.11	12.70
6 × 4	16.78	12.44	9.83	13.02	14.29	12.25	7.61	11.38
5	19.67	11.19	9.64	13.50	20.98	14.20	10.14	15.10
6 × 5	58.21	37.08	29.67	41.66	57.75	41.51	27.31	42.19
6	25.11	19.61	15.36	20.03	25.66	15.38	10.37	17.14
Comparative class	31.47	19.90	16.35	22.57	25.24	19.83	15.44	20.17
A. F. M. 5%		**3.77**		**2.17**		**3.82**		**2.23**
	47.35	**30.05**	**22.69**	**33.36**	**40.78**	**26.24**	**19.5**	**28.84**
A. F. M. 5%		**1.18**				0.86		

Reference

Ahmad, S.Q.; Khan, S.; Ghaffar, M. and Ahmad, F. (2011). Genetic diversity for analysis for yield and other parameters in maize (*Zea mays* L.) Genotypes. Asian. J. of Agric. Sci., 3(5): 385 – 388.

Ali, N. and Anjum, M.M. (2017). Effect of different nitrogen rates on growth, yield and quality of maize. Middle East Journal of Agriculture Research, 6(1): 107-112.

Balem, Z.; Modolo, A.J.; Trezzi, M.M.; Vargas, T.; Baesso, M.M.; Brandelero, E.M. and Trogello, E. (2014). Conventional and twin row spacing in different population densities for maize (*Zea mays* L.). African J. of Agric. Res. 9(23): 1787- 1792. Basbag.

Bello, O.B.; Ige, S.A.; Azeez, M.A.; Afolabi, M.S.; Abdulmaliq, S.Y. and Mahamood, J. (2012). Heritability and genetic advance for grain yield and its component characters in maize (*Zea mays* L.). Inter. J. of Plant Res. 2(5): 138- 145.

Bodirsky, B.L.; Popp, A.; Lotze-Campen, H.; Dietrich, J.P.; Rolinski, S.; Weindl, I. and Stevanovic, M. (2014). Reactive nitrogen requirements to feed the world in 2050 and potential to mitigate nitrogen pollution. Nat Commun, 5: 3858.

Chakwizira, E.; Teixeira, E.I.; de Ruiter, J.M.; Maley, S. and George, M.J. (2016). Harvest index for biomass and nitrogen in maize crops limited by nitrogen and water. Proceedings of the 2016 International Nitrogen Initiative Conference, "Solutions to improve nitrogen use efficiency for the world", 4 – 8 December 2016, Melbourne, Australia. www.ini2016.com

Clarke, J. (2014). Using Genomics to Improve Drought Tolerance in Corn Hybrids. ICommunity, (November).

Dixon, R.C. (2003). Foliar Fertilization Improves Nutrient Use efficiency. Fluid J. 40: 22-23.

Dona, A.F.; Miranda, G.V.; De-Lima, R.O.; Chaves, L.G. and e-Gama, E.E.G. (2012). Genetic parameters and predictive genetic gain in maize modified recurrent selection method. Chilean J .of Agric. Res. 72(1): 33 – 39.

El-Mekser, H. Kh. and Badawy, S.A. (2015). Nitrogen use efficiency of some maize hybrids. J. Food, Agriculture and Environment (JFAE), 13(2):138-142.

Griffing, B. (1956b). Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. of Bio. Sci., 9: 463-493.

Gözübenli, H. and Konu Kan, Ö. (2010). Nitrogen dose and plant density effects on popcorn grain yield. Afr. J. Bio., 9(25): 3828-3832.

Hefny, M.M. and Aly, A.A. (2008). Yield ability and nitrogen use efficiency in maize inbred lines and their crosses. International J. Agric Res. 3(1) : 27 - 39.

Moll, R.H.; Kamprath, E.J. and Jackson, W.A. (1982). Analysis and interpretation of factors which contribute to efficiency of nitrogen-utilization. Agronomy Journal 74: 562-564.

Moose, S. and Below, F.E. (2009). Biotechnology approaches to improving maize nitrogen use efficiency. Biotechnology in Agriculture and Forestry, 63: 65–77.

Muchow, R.C. and Sinclair, T.R. (1994). Nitrogen response of leaf photosynthesis and canopy radiation use efficiency in field grown maize and sorghum. Crop Sci., Medison, 3(4): 721-723.

Norton, R.; Davidson, E.; Roberts, T.; Crosby, G. and Erisman, J.W. (2015). Nitrogen Use Efficiency and Nutrient Performance Indicators Global Partnership on Nutrient Management Contributors About the Global Partnership on Nutrient Management GPNM Steering Committee.

Olaniyan, A.B.; Akintoye, H.A. and Balogun, M.A. (2004). Effect of different sources and rates of nitrogen fertilizer on growth and yield of sweet corn. National Horticultural Research Institute, Vegetable Production, Nigeria [online]

Sarjamei, F.; Khorasani, S.K. and Nezhad, A.J. (2014). Effect of planting methods and plant density, on morphological, phonological, yield and yield component of baby corn. Adv. in Agric. and Biol., 2(1): 20 -25.

Tollenaar, M.; Ahmadzadeh, A. and Lee, E.A. (2004). Physiological basis of heterosis for grain yield in maize. Crop Sci., 44: 2086-2094.

Wuhiab, K.M.; Hadi, B.H. and Hassan, W.A. (2016). Hybrid vigor, heterosis, and genetic parameters in maize by diallel cross analysis. Int. J App. Agri. Sci., 2(1): 1-11.

الداودي, علي حسين رحيم وخالد خليل احمد الجبوري ومحمد ابراهيم محمد العكيدي. 2015. اداء ثلاثة هجن من الذرة الصفراء (*Zea mays* L.) للكثافة النباتية والسماد النتروجيني. مجلة ديالى للعلوم الزراعية. 7 (1): 133-147.

عبد, راضي ذياب وزياد اسماعيل عبد. 2010. تربية محاصيل لكفاءة استخدام النتروجين. مجلة العلوم الزراعية العراقية. 41(4): 47-64.

علي, نور الدين شوقي. 2012. تقانات الأسمدة واستعمالاتها. وزارة التعليم العالي والبحث العلمي - جامعة بغداد.