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EVALUATION OF THE PERFORMANCE OF INTRODUCED VARIETIES OF MAIZE UNDER DIFFERENT PLANTING DATES AND ENVIRONMENTS

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Abstract

A field experiment was carried out in two locations, the College of Agricultural Engineering Sciences - the University of Baghdad in Jadriya and the second in Muqdadiya District, fields of the Directorate of Agriculture of Diyala Governorate. The main study aim was to evaluate the performance of introduced varieties of maize under different planting dates and locations, and comparing them with a local variety, for the fall season 2019. Furthermore, the study included a comparison of five varieties of maize introduced from America (var 1 = 5401 DKC, var 2 = 5783 DKC, var 3 = 6315 DKC, var 4 = 6590 DKC, var 5 = 6815 DKC), with a local synthetic variety (IPA 5018) were tested in two locations at three planting dates, 1 and 15 July and 1 August. Randomized Complete Block Design RCBD was used with four replication according to the split-plot arrangement; the main plots included the three planting dates, while the subplots represent the introduced varieties and the comparison variety. The characteristics of number rows/ear, number of grains/row, number of grains/ear, and single plant yield were studied. The results showed that the date of 1 August of Baghdad location exceeded with most of the studied characteristics such as the number of rows/ear (15.65 rows), and the number of grains/row (606.7 grains) and the single plant yield (213.7 g). As for the Diyala location, the date of 15 July exceeded in the rows/ear (15.12 rows), the number of grains/row (39 grains), the number of grains/ear (589 grains) and the single plant yield (182 g). Moreover, the results showed that variety 3 exceeded most of the characteristics in Baghdad location, such as the number of grains/row (36.7 grains), the number of grains/ear (546 grains), and the single plant yield (204 g). The variety 3 in Diyala location was exceeded with the highest single plant yield (188.5 g), as a result of its superiority in the number of rows, number of grains/row, and number of grains/ear. In the Aggregation -analysis, the difference between the two locations was not significant. where the two dates July 15 and August 1 exceeded with the highest single plant yield of (182.2 and 187.3 g), and the variety 3 also exceeded with the single plant yield of 196.3 g. Finally, the interaction was significant between dates and locations, between dates and varieties, and between varieties and locations, and a triple interaction of most of the studied characteristics. It can be proposed to cultivate the introduced varieties in different planting dates and locations to show their environment adaptability with the Iraqi climate during the spring season and test it under the stresses of drought and plant density.

Keywords : Maize, different Planting Dates, Environments

Introduction

The gap is still large between the rate of population increase and the rate of food production, especially in Iraq. As well as, the inadequate distribution in the cultivation of strategic crops in it, including maize (*Zea mays* L.) which is one of the crops that have high adaptability in different environments. It is cross-pollinated, so its cultivation has spread widely in different parts of the world, each environment has its hybrids and varieties. Therefore, the process of introducing different genotypes, whether varieties, hybrids, or strains, and expanding the genetic variation of the crop is one of the breeding programs that aim to improve the characteristics so that the introduction of new varieties that were superior in their productive and genetic characteristics. In addition to their ability to adapt to environmental conditions among the most important works of international companies specialized in plant breeding, and to promote the planting of maize crop, and increasing the yield per unit area, the methods of breeding and improving, and the implementation of programs to introduce new varieties, must be used. However, the import method (input) is one of the easiest breeding methods, to obtain a new variety suitable for the environment or prevailing climatic conditions. There are many cross-pollinated field crops grown in agriculturally developed countries that are originally imported from abroad and have been improved by plant breeders to suit the new area. The new imported variety in Iraq has been proven to be suitable for the environment or weather conditions in a specific region or different regions of the country was adapted depending on the nature of the region. Once comparing the performance of field crops in different environmental conditions, it can be observed a difference in performance, and for demonstrating genetic behavior in different environmental conditions, several studies indicated a group of factors that affect crop performance. These variations were divided into three sources: genetic and environmental factors and their interaction (Comstock and Moll, 1963; Hadi, 2018). (Bradshaw Allard, 1964) divided the impact of the environment into controllable factors, which are soil, date of planting, plant density and fertilizers, and other uncontrollable factors, including rain, heat, lighting, relative humidity, and location for longitude, latitude, and terrain. All of them are related to the performance of the variety and its heterogeneity characteristics, so it can observe that the planting of similar genotype from plants, differences appear between plants in some characteristics because the environment is not completely symmetrical due to the different growth factors such as moisture, nutrients, lighting, and heat. Thus, the poor genotype superior over the good genotype under heterogeneous environmental conditions because the environmental variance is not inherited, but it affects the inherited variance (genetic variation). Planting genotypes of maize in different locations is necessary to select the best in production, in addition to knowing their stability in different environmental conditions (Al-Qeisi, 2001). In order to adopt environment adaptability and its effect on changing the characteristics of the variety and increase the yield and avoid harming it with the same reasons when cultivating it in the

previous environment. The genetic resources must be changed, where the plant breeder must study the environment, the genetic-environmental interaction, and the extent of the genotypes to the growth inputs in that environment. This considers as one of the most important difficulties for plant breeders because most of the characteristics that the breeder is interested in are quantitative characteristics, which respond differently with different environmental factors and thus judge the suitability of varieties or hybrids to planting in one region without another. One of the most important things that plant breeders seek is increasing crop productivity, which is achieved either by increasing the cultivated area or increasing the productivity per unit area or both, which are related to many factors, such as environmental factors, in which the most important in determining the appropriate date of planting. Furthermore, the environmental variations are related to the different dates of planting, which has a direct impact on the growth and development of the maize crop. Each genotype has a suitable date for planting, and because of early and late cultivation results in a decrease in the yield, due to the inadequate climatic conditions after planting. Besides, during the growing season, and the associated environmental variations (sunlight and temperature), it caused effects on growth and a change in the characteristics of growth and yield of maize (Nielson *et al*., 2002; Al-Mashhadani, 2015). Moreover, planting dates have a role no less important than choosing good varieties, as setting the most appropriate date for plant growth. It is one of the basics on which the maize growing depends, especially when some farmers resort, under certain conditions, too early or delayed farming, to provide appropriate temperatures for emergence and germination, until reaching the stage of flowering and seed production, and the different Planting dates affect significantly in the grains yield and its components. The stability of the varieties performance is a property resulting from genetic-environmental interaction, and it is complicated, as many pairs of genes control them in quantitative characteristics, and that the effect of these genes for that characteristic from one environment to another is less than that of the qualitative characteristics (Bradshow, 1964; Hadi *et al*., 2018). Choosing good genotypes increases the process of photosynthesis to the optimum for vegetative growth and the grain filling, as the highest yield can be obtained when there is a compatibility between the genotypes and the available growth factors, in that environment, when these factors are optimally invested (Wuhaib, 2001). Therefore, the study aimed to cultivate several introduced varieties of maize, and test them in two locations and three different dates, to determine the best varieties in terms of production and environment adaptability variations, with the determination of the appropriate cultivation date for each variety in each environment, to increase production per unit area.

Materials and Methods

A field experiment was carried out in two locations, the first one in the fields of the College of Agricultural Engineering Sciences - the University of Baghdad in the Field Crops Department, while the second one was in Diyala Governorate - Muqdadiya District, within the agricultural fields of the Governorate Agricultural Directorate, for the autumn season 2019. The main study objective was to evaluate five varieties of maize introduced from America (Var 1 = 5401 DKC, Var 2 = 5783 DKC, Var 3 = 6315 DKC, Var 4 = 6590 DKC, Var 5 = 6815 DKC), and compare it with a local synthetic variety and test it under three cultivation dates: 1/7, 15/7 and 1/8. The land was prepared for cultivation and the two experiment locations of perpendicular plowing, harrowing and leveling according to recommendations, and the land was divided into plots (3 x 3 m), where the distance between a line and another 70 cm and between one plant and another 20 cm. Fertilizing with triple superphosphate fertilizer (46% P_2O_5) of 200 kg P_2O_5.ha^{-1} in one batch before cultivation, and nitrogen fertilizer 350 kg N. ha^{-1} in the form of urea (46% N) in three batches, the first was two weeks after germination, the second at a plant height of 30 cm, and the third after flowering. A preventive control against the corn borer (*Sesamia cretica* L.) was carried out using granulated Diazinon at a concentration of 10% at a rate of 4 kg.ha^{-1} in two batches, the first at a plant height of approximately 25 cm and the second 15 days after the first control. As the weeding process was carried out manually and for several times during the season and as needed, as well as the field irrigation was carried out as needed. Cultivation was carried out in the plots (3 x 3) on lines with a distance of 70 cm between one line and another and the distance between one plant and another 20 cm. The seeds were planted at a rate of 3-2 seeds in each hole and the number of plants was reduced to one plant after reaching two leaves per plant. Similarly, the experiment land divided for the two locations into three replicates according to the design (RCBD), and the number of genotypes and planting dates were distributed to the experimental units by 72 experimental. Five intermediate plants were taken randomly selected for each experimental unit excluding peripheral plants. The plants were harvested on three dates: 10/10, 21/10, and 11/11/2019 for Baghdad location for the three planting dates respectively, and 15/10, 29/10, and 19/11/ 2019 for Diyala location for the three planting dates respectively. The characteristic data were recorded, number of rows/ear, number of grains/row, number of grains/ear, and single plant yield (g). Finally, Statistical analysis for each of the characteristics was done according to the ANOVA variance analysis using the split-plot arrangement. The significance was tested using F test at a significance level of 0.05, mathematical Means were compared using LSD (the least significant difference) with a significance level of 0.05 for all Means according to (Steel and Torrie, 1980) using the commercial Genestat 2014 program.

Results and Discussion

Number of rows/ear

The results of the analysis of variance in the Means Table 1 indicated that there were significant differences between the varieties and planting dates and their interactions for the two experiment locations Baghdad and Diyala. The last date of August 1 exceeded with the highest number of rows/ear reached 15.65, where the second date July 15 did not differ significantly from it in the number of rows/ear and reached 15.40. Furthermore, the plants of the first date, July 1, gave the lowest number of rows/ear with an Means of 13.24 at the Baghdad location. Whereas at the Diyala location, the second and third dates gave the same number with 15.12 rows/ear, which exceeded the first date, which gave the lowest number by 14.43 rows/ear. The reason may be due to the environmental conditions surrounding the plant, as late dates in the autumn season are accompanied by moderation in temperatures, increased relative humidity, and

a moderate photoperiod, which increases the process of photosynthesis. Thus, the accumulation of dry matter increased and the success of the pollination and fertilization processes and increasing the number of rows/ear, where these results present a good agreement with (Aziz, Mohammed 2012; Al-kaisy, 2015; Al-Mashhadani, 2015, Regab, and Jassim 2016) findings. As for the varieties, it can be observed from the Means Table 1, that the comparison variety exceeded the introduced varieties with the highest number of rows/ear, which reached 16.12 at the Baghdad location. Furthermore, the introduced varieties, variety 2 exceeded with the highest number of rows/ear amounted to 15.18, and variety 3 did not differ significantly from it with the number of rows/ear reached to 14.64, which did not differ significantly from varieties 4 and 5. The variety 3 was exceeded with the highest number of rows/ear by 15.80, and it differed significantly from the rest of the varieties and the comparison variety, followed by the comparison variety with the number of rows of 15.08. Besides, the two introduced varieties 1 and 2, which did not differ significantly from each other and the comparison variety, whereas the variety 4 plants gave the lowest number of rows, amounted to 14.16, and it did not differ significantly from the variety 5, which gave 14.49 rows. The reason for the varieties differ in the number of rows is due to the genetic nature of each variety, because the number of rows/ear is related to the nature of the genotype, this result confirms the findings of (Aziz and Mohammed 2012; Al-kaisy 2015; Al-Mashhadani 2015; Al-Ruome, 2016; Anees *et al*., 2017). There was a significant interaction between varieties and planting dates in both locations, where the response was in increasing the number of rows/ear of last two dates compared to the first date of July 1. In addition, the highest response was 3.73 rows, an increase in the number of rows for variety 1 in the last date over the first, followed by the variety 3 with a response of 3.27 rows, at Baghdad location. Similarly, at Diyala location, the interaction was significant between varieties and planting dates, and the response was also in increasing the number of rows/ear of the last two dates compared to the first date of July 1, except the comparison variety in which the number of rows was decreasing with the progress of planting dates towards August. Variety 3 exceeded with the highest number rows/ear for the three dates 15.65, 15.55, and 16.20 rows/ear respectively. The highest response between the first and last dates for the varieties 1 and 2 with a difference in the number of rows/ear of 1.97 and 2.20 rows for the two varieties respectively. The comparison variety was also distinguished by the absence of significant differences between the number of rows in it according to the three planting dates, as the three dates gave the number of rows/ear amounted to 15.33, 15.20, and 14.70 for dates 1, 2 and 3, respectively. A Aggregation-analysis, Table 2 indicated that there were significant differences for the treatments of planting dates, varieties, the interaction between locations x dates, the interaction between varieties x locations, the interaction between varieties x dates, and triple interaction between locations x dates x varieties, while no significant differences were recorded for locations treatments in the number of rows/ear. The reason may be that the characteristic is related to the genetic nature of the cultivated varieties and the planting locations did not affect them. This result agreed with (Al-Qeisi, 2001) findings, where no significant differences were found in the characteristic of the number of rows/ear in different locations, while this result is not consistent with (Kanoosh, 2011), that observed significant differences in the number of rows/ear when cultivating the maize plant in two locations of Nineveh Governorate. The plants of the third date, August 1, gave the highest number of rows/ear of 15.38 rows, which did not differ significantly from the second date of July 15, that their plants gave an Means of 15.26 rows/ear, while the first date of July 1 gave the lowest number of rows/ear of 13.84 rows. Similarly, the varieties differed significantly among themselves in the number of rows/ear, as the comparison variety exceeded and gave a number of rows/ ear of 15.60 compared to the introduced varieties, variety 3, 2, 4, 1 and 5 by 15.22, 15.10, 14.14, 14.34 and 14.37 rows / ear, respectively. The interaction was significant between locations and planting dates, as plants of the last date of August 1 of Baghdad location gave the highest number of rows / ear of 15.65, and the second date of July 15 did not differ from it for the same location with the number of rows / ear of 15.40 rows. As for the Diyala location, the second and third dates are equal in the same number of rows / ear of 15.12. The interaction was significant between the varieties and locations, and the direction of the interaction was fluctuating between the increase and decrease with the difference two locations. Comparison variety exceeded by the highest number of rows / ear of 16.12 rows at the Baghdad location, and the variety 3 did not differ significantly from it in the Diyala location which gave 15.80 rows/ear , while the lowest number of rows / ear of variety 1 was 13.89 in the Baghdad location.

Table 1 : Means number of rows/ear for introduced varieties of maize at three planting dates in the Baghdad and Diyala locations for the fall season 2019

	Baghdad				**Diyala**			
	July 1	**July 15**	**Aug.1**	**Means**	**July 1**	**July 15**	**Aug. 1**	**Means**
Variety 1	11.77	14.40	15.50	13.89	13.83	14.75	15.80	14.79
Variety 2	13.83	15.35	16.35	15.18	13.65	15.55	15.85	15.02
Variety 3	12.33	16.00	15.60	14.64	15.65	15.55	16.20	15.80
Variety 4	13.50	15.43	14.60	14.51	14.17	14.25	14.05	14.16
Variety 5	13.00	15.13	14.60	14.24	13.98	15.40	14.10	14.49
Comparison	15.00	16.10	17.25	16.12	15.33	15.20	14.70	15.08
L.S.D 0.05		1.09		0.63		0.88		0.51
Means	13.23	15.40	15.65		14.43	15.12	15.12	
L.S.D 0.05		0.42				0.27		

In Diyala, the comparison variety gave 15.08 rows/ear and it did not differ significantly from varieties 1 and 2 for the same location. The interaction between the varieties and dates was also significant, and it was with increasing the number of rows/ear for the last two dates from the date of July 1, in which the varieties gave the lowest rates for the characteristic. However, the highest response was for the variety 1, in which the number of rows increased by 2.85 rows/ear with the progress of the planting date one month. The comparison variety exceeded by maintaining a close rate of the trait, according to the different cultivation dates, with the number of rows reached 15.16, 15.65, and 15.98 rows/ear for the three dates respectively. The triple interaction between the locations, the varieties, and the dates also were significant, and the comparison variety gave the highest number of rows/ear at the last date amounted to 17.25 rows/ear, while the lowest varieties in the number of rows/ear were variety 1 which reached 11.77 rows at the first date at the same location.

Table 2 : The Aggregation -analysis Means number of rows/ear for introduced varieties of maize at three planting dates in the Baghdad and Diyala locations for the autumn season 2019.

The Aggregation-analysis												
Varieties x Dates x Locations							Varieties x Locations		Varieties x Dates			Means
Varieties	July 1		July 15		August 1		Baghdad	Diyala	July 1	July 15	August 1	
	Baghdad	Diyala	Baghdad	Diyala	Baghdad	Diyala						
Variety 1	11.77	13.83	14.40	14.75	15.50	15.80	13.89	14.79	12.80	14.58	15.65	14.34
Variety 2	13.83	13.65	15.35	15.55	16.35	15.85	15.18	15.02	13.74	15.45	16.10	15.10
Variety 3	12.33	15.65	16.00	15.55	15.60	16.20	14.64	15.80	13.99	15.78	15.90	15.22
Variety 4	13.50	14.17	15.43	14.25	14.60	14.05	14.51	14.16	13.83	14.84	14.33	14.33
Variety 5	13.00	13.98	15.13	15.40	14.60	14.10	14.24	14.49	13.49	15.26	14.35	14.37
Comparison	15.00	15.33	16.10	15.20	17.25	14.70	16.12	15.08	15.16	15.65	15.98	15.60
L.S.D 0.05	0.94						0.56		0.69			
Means	13.24	14.43	15.40	15.12	15.65	15.12	14.76	14.89	13.84	15.26	15.38	0.40
L.S.D 0.05	0.31						N.S		0.22			

Number of grains/row

The number of rows and the number of the spikelet in a row are important factors in increasing the number of grains, which depend mainly on the proportion of pollination and fertilization, and are among the genetic characteristics that may be affected, relatively by environmental factors (Elsahookie, 2009). The results of the analysis of variance in Table 3 showed that there were significant differences between the varieties, planting dates, and their interactions, for both experiment locations Baghdad and Diyala. The plants of the last date, August 1, gave the highest number of 38.76 of grains/row, followed by the second date 15 July; while plants of the first date of July 1 gave, the lowest number amounted to 29.66 grains/row for Baghdad location. Furthermore, the plants of the second date of July 15 exceeded by giving the highest number of grains/row of 39.01 grains, followed by the last date of August 1, while the lowest number of grains/row was for the first date plants, which reached 32.92 grains at Diyala location. The availability of favorable conditions of moderate temperature and humidity was essential in the success of pollination and fertilization processes. Thus, it allowing increasing the number of grains/row, where this result is consistent with (Al-Mashhadani 2010; Al-Mashhadani, 2015; Mahmood *et al*., 2017), and it does not agree with (Aziz, Mohammed 2012, Al-kaisy 2015, Regab, and Jassim 2016) results, by indicated that there was no effect of planting dates in this characteristic. Table 3 also indicates that the varieties differ significantly between them, where the variety 3 exceeded with the highest number of 36.72 grains/row, and it did not differ significantly from variety 4 and the comparison variety that gave 35.38 and 35.41 of grains/row. The variety 5 gave the lowest number of grains/row of 32.83 grains, and it did not differ significantly from variety 1, which gave 33.61 grains/row at Baghdad location. Similarly, variety 4 exceeded with the highest number of grains/row by 37, which did not significantly different from variety 3. Furthermore, variety 1 has the lowest number of grains/row of 34.21 grains, and it did not differ significantly from varieties 2 and 5 at Diyala location. This reflects the genetic difference between the varieties in this characteristic, as each genotype has a genetic ability to produce a certain number of grains/row, as well as its difference in the fertility rate, these results confirm the results of (Aziz and Mohammed 2012; Kaisy, 2015; Al-Mashhadani 2015; Regab, Jassim 2016; Mahmood *et al*., 2017). As for the interaction between the varieties and the planting dates, it was significant for both locations. It was with increasing the number of grains/row at Baghdad location in the ear whenever the planting dates were in the month of August. However, four of the introduced varieties 1, 2, 3 and 5 exceeded in their response reached 9.96, 8.79, 10.63 and 11.07 grains/row respectively over the comparison variety that its response reached 8.02 grains/row, while variety 4, its response was less than the comparison variety of 6.17 grains. At Diyala location, the interaction was also significant between varieties and planting dates, it can be observed at the first date that all varieties gave the lowest number of grains/row and that grains/row was increasing to reach their maximum value at the planting date of July 15. Then, it began to decrease at the last planting date, and the response between the first and second dates was less than in the Baghdad location and amounted to 9.83, 4.25, 6.32, 4.57, 4.04, and 7.55 for the five varieties and the comparison variety respectively, and it can observe the superiority of variety 1 in the response amount. A Aggregation-analysis, the Table 4 of analysis of variance indicated that there were significant differences between the two experiment locations, and between the planting dates, varieties, interaction between

locations x dates, the interaction between varieties x dates, and triple interaction between locations x dates x varieties. the interaction between the varieties x locations was not significant, where the plants of the second location Diyala gave the highest number of grains/row of 35.94 grains compared to the first location of Baghdad, that its plants gave an Means number of grains/row of 34.81 grains. The difference in environmental conditions between the two locations from temperature and relative humidity, especially since the last dates are accompanied by a moderate temperature, which is reflected in the success of the pollination and fertilization processes and the increase in the number of grains/row (Kanoosh, 2011). The second date exceeded by the highest number of grains/row reached 307 grains, and the third date did not differ significantly from it, that its plants gave means of 37.32 grains, while the first date was the lowest dates in this characteristic by 31.29 grains/row. Moreover, the varieties differed significantly between them in the Aggregation-analysis, the introduced variety 3 was the highest varieties by giving the highest number of grains/row of 36.97, which did not differ significantly from variety 4 and the comparison. The variety 1 the lowest varieties in the number of grains/row of 33.91, which did not, did not differ significantly from the variety. As for the interaction between the locations and the dates, it can be observed that the Diyala location exceeded Baghdad location in the first and second dates in this characteristic. Baghdad location exceeded in the first date July 1, the second date 15th of July for the Diyala location exceeded with the highest number of grains/row reached 39.01 grains, and the last date of August 1 at the Baghdad location did not differ significantly from it, which gave 38.76 grains. The interaction of the varieties with the locations was not significant, while the interaction between the varieties and the planting dates was significant in the number of grains/row, and that all varieties in the second and third dates were with increasing the number of grains/row compared to the first date. The highest number of grains/row was 40.23 for the variety 3 at the second date, with an increase of 7.94 grains /row compared to the first date, while the lowest varieties in the number of grains/row were the variety 1 at the first date, which gave 28.33. Also, the triple interaction between the locations, dates, and varieties was significant, and it was with increasing the number of grains/row of Diyala location over Baghdad location in the first and second dates, while the third date, the number of grains in Diyala location over Baghdad location reduced. Variety 3 gave the highest number of grains in Diyala location at the second date reached 40.90 grains; it did not differ significantly from Baghdad location in the second and third dates, as it gave 39.55 and 40.63 respectively. As well as, the variety 4 it did not differ significantly from it at the same date and location and the comparison variety on the second date in Diyala, and the third date in Baghdad.

Table 3 : Means number of grains/row for introduced varieties of maize at three planting dates in the Baghdad and Diyala locations for the autumn season 2019.

	Baghdad				**Diyala**			
	July 1	**July 15**	**Aug.1**	**Means**	**July 1**	**July 15**	**Aug. 1**	**Means**
Variety 1	28.49	33.90	38.45	33.61	28.17	38.00	36.45	34.21
Variety 2	29.66	36.55	38.45	34.89	33.00	37.25	34.55	34.93
Variety 3	29.99	39.55	40.62	36.72	34.58	40.90	36.15	37.21
Variety 4	32.13	35.70	38.30	35.38	35.83	40.40	36.10	37.44
Variety 5	26.33	34.75	37.40	32.83	33.41	37.45	34.35	35.07
Comparison	31.33	35.55	39.35	35.41	32.50	40.05	37.70	36.75
L.S.D 0.05		2.32		1.34		2.69		1.56
Means	29.66	36.00	38.76		32.91	39.01	35.88	
L.S.D 0.05		2.36				1.76		

Table 4 : The Aggregation-analysis of Means number of grains/row for introduced varieties of maize at three planting dates in the Baghdad and Diyala locations for the autumn season 2019

The Aggregation-analysis												
Varieties x Dates x Locations							**Varieties x Locations**		**Varieties x Dates**			**Means**
Varieties	**July 1**		**July 15**		**August 1**		**Baghdad**	**Diyala**	**July 1**	**July 15**	**August 1**	
	Baghdad	**Diyala**	**Baghdad**	**Diyala**	**Baghdad**	**Diyala**						
Variety 1	28.50	28.17	33.90	38.00	38.45	36.45	33.62	34.20	28.33	35.95	37.45	33.91
Variety 2	29.66	33.00	36.55	37.25	38.45	34.55	34.89	34.93	31.33	36.90	36.50	34.91
Variety 3	30.00	34.58	39.55	40.90	40.63	36.15	36.72	37.21	32.29	40.23	38.39	36.97
Variety 4	32.13	35.83	35.70	40.40	38.30	36.10	35.38	37.44	33.98	38.05	37.20	36.41
Variety 5	26.33	33.41	34.75	37.45	37.40	34.35	32.83	35.07	29.87	36.10	35.87	33.95
Comparison	31.33	32.49	35.55	40.05	39.35	37.70	35.41	36.75	31.91	37.80	38.52	36.08
L.S.D 0.05	2.84						N.S		1.75			
Means	29.66	32.91	36.00	39.01	38.76	35.88	34.81	35.94	31.29	37.50	37.32	1.01
L.S.D 0.05	1.85						0.78		1.31			

Number of grains/ear

The results of the analysis of the variance of Table 5 indicated that the presence of significant differences between the characteristic means of the planting dates, varieties, and their interaction and the two experiment locations Baghdad and Diyala. The last date of August 1 gave the highest number of reached 606.7 grains/ear with an increase of 9.24% and 54.38% over the second and first dates, respectively, which they gave 555.4 and 393.0 grains/ear at

Baghdad location. The second date exceeded by giving the highest Means number of grains/ear, which reached 589.4 grains over the third date, with the number of 47,1 grains/ear, and over the first date with the number of grains/ear reached 113.8 grains, which gave the lowest number of 475.6 grains/ear at. The superiority of the last date of Baghdad location and the second in Diyala in the number of grains/ear is due to the availability of appropriate conditions at the two dates, especially the moderate temperature in the last dates of the autumn season. In addition to the relative humidity and the moderate photoperiod in a manner, that makes its superiority in both the number of rows/ear and the number of grains/rows as shown in Tables 5 and 6. Furthermore, the number of grains/ear tablets thus increased, this result confirms what (Kanoosh 2011; Hokmalipour 2011; Aziz and Mohammed 2012; Al-Mashhadani 2015) pointed out. Varieties differed significantly between them by the number of grains/ear, the comparison variety significantly exceeded the introduced varieties with the highest number of grains/ear by 573.6 at Baghdad location. As for the introduced varieties, the variety 3 exceeded by the highest number of grains/ear amounted to 545.9, which did not differ significantly from variety 2. Variety 5 gave the lowest Means number of grains/ear amounted to 471.3 grains that did not differ significantly from variety 1 with an Means of 472.5 grains/ear. Furthermore, variety 3 exceeded all the introduced varieties and the comparison variety, and gave the highest number of grains/ear of 587.6 grains with an increase of 33.3 grains compared to the comparison variety that gave 553.8 grains; variety 4 did not differ from it by the number of grains/ear reached 530.1 grains. The lowest varieties in the number grains/ear were variety 5 which gave 509.1 grains/ear, and varieties 1, 2, and 4 did not differ significantly from it, which gave means for the number of grains/ear of 508.5 and 526 .1 and 530.1 grains, respectively. From this, it can observe that for each genotype there is a genetic rule that controls the characteristic number of grains/ear. As the two superior genotypes in the two experiment locations, variety 3 and the comparison variety have the best genetic rule among other genotypes. They exceeded in the number of grains/ear and the number of grains/rows as shown in Tables 1 and 3, and because these characteristics increasing, leading to an increase in the number of grains/ear as mentioned by (Aziz and Mohammed 2012; Al-Mashhadani 2015). There was a significant interaction between varieties and planting dates for the Baghdad location, and it was with increasing the number of grains/ear whenever the dates were in August. Furthermore, the highest response to increasing the number of grains/ear was from July 1 to August 1 for varieties 4, 1, and 2 with an increase of 262.8, 261.9, and 218.2 grains for the three varieties respectively. Besides, the lowest response of the increase in the number of grains between the first and last locations is 125.5 grains for a variety of 5 of the introduced varieties. In Diyala's location, the interaction between the varieties and dates was significant also, the response of variety 1 was with increasing the number of grains/ear with the progress of dates until August by an increase of 186.8 grains/ear. As for the rest of the introduced varieties and the comparison variety, the response was with the increase in the number of grains/ear from the first date July 1, and reaching its maximum value at the second date, July 15, then on the last date, August 1, it returns to reduce than it was on July 15. In the Aggregation-analysis, Table 6 indicated that there were significant differences for location treatments, planting dates, varieties, the interaction between sites x varieties, and between varieties x locations, between varieties x dates, and triple interaction between locations x dates x varieties. The highest number of grains/ear in Diyala location was 535.9 grains with an increase of 17.5 grains from the Baghdad location, which gave means number of grains/ear of 518.4 grains. Since the number of grains/ear is the final result of the multiplication of the number of rows/ear x number of grains/row as shown in Tables 1 and 3. Therefore, the characteristic of the number of grains/ear in the Diyala location increased due to the increase in the two characteristics mentioned in this location. Furthermore, the plants were also affected by environmental conditions of heat, relative humidity, and photoperiod, this indicates the difference in the performance of genotypes between the two locations in the studied characteristics, this agreed with (Kanoosh, 2011). Table 6 of the Aggregation-analysis indicated that the planting date varied significantly between them, where the highest number of grains/ear was for the last date of August 1 with an Means of 574.6 grains, which did not differ significantly from the second date. Compared to plants of the first date, which gave the lowest number of grains/ear reached 434.3 grains. Varieties differed significantly between themselves in the Aggregation-analysis, as the introduced variety 3 was superior over the rest of the introduced varieties and the comparison variety with the highest number of grains/ear of 566.8 grains. As well as, the comparison variety did not differ from it, which gave 563.7 grains, followed by varieties 2 and 4, which gave a number of grains/ear of 529.5 and 522.2 grains, and they did not differ significantly from each other. Variety 5 was the lowest varieties in the number of grains/ear with an Means of 490.2 grains, and the variety 1 did not differ significantly from it, that gave a number grains/ear 490.5 grains. The interaction was significant between the locations and dates, the plants on the last date of August 1 for the Baghdad location exceeded with the highest number of grains/ear of 606.7 grains, and the second date of July 15 of Diyala location was not significantly different from it, which gave 589.5 grains. Whereas, the first date for the Baghdad location gave the lowest number of grains/ear, which was 393.0 grains, and differed significantly from the same date for the Diyala location with a difference of 82.6 grains. The interaction was significant between the varieties and the locations, and it was with the increasing of the number of grains/ear in Diyala location from Baghdad location for most of the introduced varieties. As for the comparison variety, the number of grains/ear in the Baghdad location was higher than the Diyala location, and its value did not differ significantly between the two locations, while variety 3 gave the highest number of grains/ear in Diyala location, which amounted to 587.6 grains superior to all varieties and in both locations. Moreover, the variety 5 was the lowest varieties in the number of grains/ear with an Means of 471.3 grains at the Baghdad location. As for the interaction between the varieties and the dates, it was also significant and was with increasing the number of grains/ear in the two dates July 15 and August 1 for all varieties compared to the first date of July 1. Variety 3 gave the highest number of grains/ear at the second date amounted to 635.1 grains, and it did not differ significantly at the third date and from comparison variety at the third date, whereas in variety 1 was the lowest varieties in the number of grains/ear at the first date reached 361.5

grains. The triple interaction was also significant between locations, dates, and varieties, and it was with increasing the number of grains/ear in the Diyala location varieties compared to Baghdad location for the first and second dates, while the third date, the varieties were decreasing in the number of grains/ear in the Diyala location from the Baghdad location. Finally, the comparison variety exceeded at the last date in Baghdad location with the highest number of grains/ear of 678.1 grains, variety 3 did not significantly different from it for the same date and location, and from the second date for Baghdad and Diyala locations. The lowest varieties in the number of grains/ear were variety 1 at the first date of Baghdad location, and varieties 3 and 5 did not differ significantly from it at the same date and location.

Table 5 : Means number of grains/ear for introduced varieties of maize at three planting dates in the Baghdad and Diyala locations for the autumn season 2019.

	Baghdad				**Diyala**			
	July 1	**July 15**	**Aug.1**	**Means**	**July 1**	**July 15**	**Aug. 1**	**Means**
Variety 1	333.8	487.8	595.7	472.5	389.1	560.6	575.9	508.5
Variety 2	409.5	560.6	627.7	532.6	451.7	579.3	547.3	526.1
Variety 3	370.5	634.0	633.3	545.9	540.7	636.2	585.9	587.6
Variety 4	433.4	550.5	558.9	514.3	507.1	575.8	507.3	530.1
Variety 5	341.9	525.7	546.4	471.3	466.9	575.8	484.5	509.1
Comparison	469.1	573.6	678.1	573.6	498.3	609.0	554.0	553.8
L.S.D 0.05		46.1		26.6		50.6		29.2
Means	393.0	555.4	606.7		475.6	589.4	542.5	
L.S.D 0.05		38.3				23.7		

Table 6 : The Aggregation-analysis of Means number of grains/ear for introduced varieties of maize at three planting dates in the Baghdad and Diyala locations for the autumn season 2019

The Aggregation-analysis												
Varieties x Dates x Locations							**Varieties x Locations**		**Varieties x Dates**			**Means**
Varieties	**July 1**		**July 15**		**August 1**		**Baghdad**	**Diyala**	**July 1**	**July 15**	**August 1**	
	Baghdad	**Diyala**	**Baghdad**	**Diyala**	**Baghdad**	**Diyala**						
Variety 1	333.8	389.1	487.8	560.6	595.7	575.9	472.5	508.5	361.5	524.2	585.8	490.5
Variety 2	409.5	451.7	560.6	579.3	627.7	547.3	532.6	526.1	430.6	569.9	587.5	529.4
Variety 3	370.5	540.7	634.0	636.2	633.3	585.9	545.9	587.6	455.6	635.1	609.6	566.8
Variety 4	433.4	507.1	550.5	575.8	558.9	507.3	514.3	530.1	470.2	563.2	533.1	522.2
Variety 5	341.9	466.9	525.7	575.8	546.4	484.5	471.3	509.1	404.4	550.8	515.4	490.2
Comparison	469.1	498.3	573.6	609.0	678.1	554.0	573.6	553.8	483.7	591.3	616.0	563.7
L.S.D 0.05	50.7						27.6		33.8			
Means	393.0	475.6	555.4	589.5	606.7	542.5	518.4	535.9	434.3	572.4	574.6	19.5
L.S.D 0.05	28.4						16.6		20.1			

Plant yield (gm)

The results of Table 7 indicated the presence of significant differences between the varieties, dates, and their interaction for the two experiment locations, Baghdad and Diyala. The last date of August 1 exceeded with means single plant yield amounted to 213.7 g.plant^{-1}, followed by the second date; July 15 with a single plant yield reached 182.1 g.plant^{-1}. Furthermore, the first and second dates exceeded with an increase of 99.5% and 70.0% compared to the first date of July 1, in which the single plant yield reached 107.1 g.plant^{-1} the first location, Baghdad. Similarly, the second date gave the highest Means rate of single plant yield of 182.3 g.plant^{-1} with an increase of 13.4% over the first date, which decreased to give the lowest single plant yield of 158.0 g.plant^{-1}, and it did not differ significantly compared to the last date at Diyala location. The reason that the last date of Baghdad location and the second date of Diyala location exceeded is due to the availability of appropriate environmental conditions, from moderate temperatures, increased relative humidity during the flowering period, and the positive impact on the viability of pollen. Thus, the success of the pollination process, this led to an increase in both the number of rows/ear and the number of grains/row and the number of grains/ear as shown in Table 1, 3 and 5. In addition to the appropriate conditions that enabled the plant to exploit its physiological capabilities to produce a high grain yield, this result confirmed the results of (Al-Mashhadani, 2010; Bakht *et al*., 2011, Aziz, Mohammed, 2012; Kaisy, 2015, Al-Mashhadani, 2015, Regab, and Jassim 2016). Varieties differed significantly between them, as the results indicate the superiority of variety 3 in the Baghdad location with the highest Means of single plant yield of 204.1 g.plant^{-1} with an increase of 14.5% over the comparison variety, which gave an Means of the single plant yield of 178.2 g.plant^{-1}. Besides, variety 2 did not differ from it with a single plant yield of 181.7 g.plant^{-1}. While variety 5 gave the lowest Means of single plant yield of 143.5 g.plant^{-1}, and varieties 1 and 4 did not differ significantly from it, which gave means yield of 146.6 and 151.6 g.plant^{-1}. At Diyala location, the varieties varied significantly in the Means single plant yield, and also the superiority of variety 3 with the highest Means single plant yield reached 188.5 g.plant^{-1}, followed by variety 4 with an Means of 170.6 g.plant^{-1}. Variety 1 gave the lowest Means single plant yield of 149.7 g.plant^{-1}, whereas the means single plant yield for the comparison variety was 168.3 g.plant^{-1}, which did not differ significantly compared to the varieties Means 2, 4 and 5, that reached 162.0, 170.6 and 163.0 g.plant^{-1}, respectively, for the single plant yield. The superiority of variety 3 in the two

locations is attributed to the genetic nature of the variety, its different response to environmental conditions, the better investment of solar energy, and the increase in the efficiency of photosynthesis. In addition to the high rates of many characteristics, including the number of rows/ear and the number of grains/row and the number of grains/ear as shown in Table 1, 3 and 5, this finding confirms by (Kanoosh 2011; Bakht *et al*., 2011, Aziz, Mohammed 2012). As well as, Kaisy 2015, Al-Mashhadani 2015, Regab and Jassim 2016), that the genotypes differ between themselves in the grain yield. At the first experiment location (Baghdad), the interaction between varieties and dates was significant, where it was with the increasing of the Means single plant yield for the varieties whenever the planting dates were in the month of August. Besides that, the maximum response was for the variety 3 by 201.9 and 130.8 g.plant^{-1} with an increase in the single plant yield on the third date, August 1 and July 15 over the first date of July 1, meaning that the increasing percentage was 216.6% and 140.3% for the two dates respectively. followed by variety 2, which increased by 101.0 and 100.7 g.plant^{-1}, an increase in the single plant yield on the third date of August 1 and the second of July 15 over the first date of July 1, meaning that the increasing percentage were 88.2% and 87.9% for the two dates respectively. As well as the single plant yield for the variety 3 increased at the last date of August 1, by 32.2% compared to the comparison variety for the same date, which gave an Means single plant yield of 223.3 g.plant^{-1}, and that the lowest response was for the comparison variety. The interaction between the varieties and dates in Diyala location was also significant, and the single plant yield of the varieties was fluctuating in the three dates, as it increased on the second date and returned to decrease in the third date. Most of the varieties gave the highest rate of single plant yield at the second date, except for the first and third cultivars, where their single plant yield increased on the last date of August 1, and the response amount for the two varieties was 45.1 and 8.3 g.plant^{-1}. The highest response of single plant yield was for variety 5 by 54.5 g.plant^{-1} between the second and first dates, as the Means single plant yield reached 205.7 g.plant^{-1} on the second date and 151.2 g.plant^{-1} on the first date. As for the Aggregation-analysis, Table 4 indicated that there were significant differences in the treatment of dates, varieties, and interaction between locations x dates, the interaction between varieties x locations, the interaction between varieties x dates, and triple interaction between locations x dates x varieties. However, there were no significant differences between the two planting locations, this finding confirms the (Al-Qeisi 2001 and Kanoosh 2011) findings, that there were no significant differences in the Means single plant yield by changing the planting locations. The three planting dates differed significantly between themselves in the characteristic of the single plant yield. As the last date, August 1 plants gave the highest means of single plant yield of 187.3 g.plant^{-1}, and did not differ significantly compared to the second date of July 15, in which the Means single plant yield reached 182.2 g.plant^{-1}. Furthermore, the two dates exceeded by an increase of 41.4% and 37.5%, respectively, compared to the first date of July 1, which its plants gave the lowest Means single plant yield of 132.5 g.plant^{-1}. Varieties differed significantly among themselves in the Means single plant yield, where the variety 3 exceeded by the highest single plant yield of 196.3 g.plant^{-1}, and increased by 13.3% over the comparison variety, which gave an Means of single plant yield of 173.3 g.plant^{-1}. It also increased by 32.5% over the variety 1, which gave the lowest Means single plant yield amounted to 148.1 g.plant^{-1}, and the yield of plant grains for the comparison variety did not differ significantly compared to variety 2, which its Means single plant yield reached 171.8 g.plant^{-1}, and differed significantly compared to the other varieties. The interaction between the locations and dates was significant, the last date of Baghdad location exceeded by an Means single plant yield of 213.7 g.plant^{-1} with an increase over the Diyala location for the same date amounted to 32.9%, and that the second date on 15 July. The two locations Baghdad and Diyala gave equal single plant yield of 182.1 and 182.3 g.plant^{-1}, for the two locations, respectively, while the lowest Means of single plant yield was at the first date of Baghdad location reached 107.1 g.plant^{-1}, and differed significantly compared to the rest of the dates, while the Diyala location did not differ significantly at the first and last dates. The interaction was significant between varieties and locations, where the plant yield in varieties 2 and 3 and comparison was lower at Diyala location than Baghdad location. The single plant yield of varieties (1, 4, and 5) increased in Diyala location compared to Baghdad location, the variety 3 at Baghdad location gave the highest Means yield of plant grains amounted to 204.1 g.plant^{-1}, and increased in Baghdad location compared to Diyala by 15.6 g.plant^{-1}. Furthermore, the lowest Means single plant yield was 146.6 g.plant^{-1} for variety 1 at Baghdad location and did not differ significantly compared to Diyala location. Similarly, it did not differ significantly compared to variety 5 for the same location (Baghdad). It evident that the comparison variety, which gave an Means single plant yield of 168.3 g.plant^{-1} in Diyala location was decreased compared to Baghdad location by 9.9 g.plant^{-}1, as the Means single plant yield in Baghdad gave 178.2 g.plant^{-1}. The interaction was significant between the varieties and dates, the performance of the varieties differed in the three dates in single plant yield, but most of the varieties gave the highest Means of yield at the second and third dates. Since, the varieties 1, 3, 4, and the comparison variety continued to increase in the three dates, and variety 3 was the highest in the response, which amounted to 245.9 g.Plant^{-1} at the last date, which increased by 74.5% over the first date. The rest of the varieties (2 and 5) were increasing at the second date and return to decrease at the last date, where the response of the comparison variety was 30.3% for the last date compared to the first one. Triple interaction between locations, dates, and varieties was also significant, where the varieties differed in the Means single plant yield between locations and dates, it evident at the first date the superiority of Diyala location over Baghdad location in the Means plant yield. Variety 3 was the highest with an Means of 188.5 g.Plant^{-1} with an increase of 102.3% compared to Baghdad location, while on the second date, the varieties were fluctuated in increasing their yield between the two locations, and the highest was variety 3 with an increase of 24.2% for Baghdad location compared to the Diyala location. As for the third date, the Baghdad location exceeded the Diyala location in the Means yield for all the varieties, and also the variety 3 exceeded by the highest Means of 295.1 g.Plant^{-1}, with an increase of 49.9% for Baghdad location compared to Diyala location. The Means yield of the plant grain for the comparison variety at the same date and location 223.3 g.Plant^{-1} with an increase of 36.6% for the Baghdad location compared to Diyala location. Finally, the lowest Means single plant yield reached

90.2 g.Plant^{-1} at the first date of Baghdad location, and did not differ significantly from varieties 3 and 4 for the same date and location.

Table 7 : Means single plant yield (g) for introduced varieties of maize at three planting dates in the Baghdad and Diyala locations for the autumn season 2019

	Baghdad				Diyala			
	July 1	**July 15**	**Aug.1**	**Means**	**July 1**	**July 15**	**Aug. 1**	**Means**
Variety 1	110.2	149.4	180.2	146.6	129.7	144.5	174.8	149.7
Variety 2	114.5	215.2	215.5	181.7	144.3	195.8	145.8	162.0
Variety 3	93.2	224.0	295.1	204.1	188.5	180.3	196.8	188.5
Variety 4	97.0	162.1	195.7	151.6	174.7	184.9	152.1	170.6
Variety 5	90.2	167.8	172.6	143.5	151.2	205.7	132.0	163.0
Comparison	137.4	174.0	223.3	178.2	159.4	182.3	163.4	168.3
L.S.D 0.05		17.2		9.9		15.4		8.9
Means	107.1	182.1	213.7		158.0	182.3	160.8	
L.S.D 0.05		12.8				8.5		

Table 6 : The Aggregation-analysis of Means single plant yield (g) for introduced varieties of maize at three planting dates in the Baghdad and Diyala locations for the autumn season 2019

The Aggregation-analysis												
Varieties x Dates x Locations							**Varieties x Locations**		**Varieties x Dates**			
Varieties	**July 1**		**July 15**		**August 1**		**Baghdad**	**Diyala**	**July 1**	**July 15**	**August 1**	**Means**
	Baghdad	**Diyala**	**Baghdad**	**Diyala**	**Baghdad**	**Diyala**						
Variety 1	110.2	129.7	149.4	144.5	180.2	174.8	146.6	149.7	120.0	146.9	177.5	148.1
Variety 2	114.5	144.3	215.2	195.9	215.5	145.8	181.7	162.0	129.4	205.5	180.6	171.8
Variety 3	93.2	188.5	224.0	180.3	295.1	196.8	204.1	188.5	140.9	202.2	245.9	196.3
Variety 4	97.0	174.7	162.1	184.9	195.7	152.2	151.6	170.6	135.8	173.5	173.9	161.1
Variety 5	90.2	151.2	167.8	205.7	172.6	132.0	143.5	163.0	120.7	186.8	152.3	153.3
Comparison	137.4	159.4	174.0	182.3	223.3	163.4	178.2	168.3	148.4	178.1	193.4	173.3
L.S.D 0.05	17.15						9.30		11.39			
Means	107.1	158.0	182.1	182.3	213.7	160.8	167.6	167.0	132.5	182.2	187.3	6.58
L.S.D 0.05	9.65						N.S		6.82			

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