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RESEARCH*ARTICLE*

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Estimations Genetic Parameters for Maize Genotypes at Different Planting Dates Growth Stages by Heat Accumulation *Zea maize* L.

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ABSTRACT

This study, conducted at the College of Agriculture, University of Kirkuk, in autumn during the growing season of 2023, aimed to examine the effect of heat accumulation on the growth and productivity of nine maize genotypes three different planting dates (July 5, July 15, and July 25). A split-plot design with a randomized complete block design with three replicate was used to analyze the impact of planting dates and genotypes on various heat accumulation stages, aiming to estimate genetic parameters variance, phenotypic variance, and expected genetic advance for each growth stage.

The findings indicated that the various planting dates had a substantial impact on heat. In early heat accumulation phases (VE, V2, and V4), The expected genetic advance values for these stages were notably high, with percentages of 29.175%, 19.077%, and 18.283%, respectively the initial date (July 5) showed strong heritability rates, suggesting the possibility of improving genetic characteristics by selection at these periods. Meanwhile, these values were lower in stages such as V6 and V8, with heritability values of 0.571 and 0.572, respectively. For the second date (July 15), heritability values were high in most stages, suggesting a significant influence of genetic factors, with moderate to high genetic advance in early stages but low in later stages like V12 (9.900%) and V14 (4.256%). For the third date (July 25), genetic and phenotypic variance values were moderate across most stages, reflecting notable genetic and phenotypic variation. Heritability values were high in almost all stages, except for the final stage(V14), which had a moderate value of 0.457627. The expected genetic advance values were moderate across most stages, suggesting the potential to improve genetic traits at certain stages

***Keywords*:** Corn, Genetic Parameters, Heat Accumulation, Planting Dates.

INTRODUCTION

Maize (*Zea mays* L.) is among Despite the importance of maize, its production in Iraq remains below the required level for various reasons. These include the influx of numerous commercial hybrids with unknown genetic origins that are not evaluated or customize to Iraqi conditions, a lack of Agricultural Censorship control over these hybrids, the absence of agricultural plans regarding cultivated areas, domestic production, and marketing mechanisms, along with other issues related to crop management and reliance on outdated techniques. Addressing these obstacles, conducting scientific research on these commercial inputs, and evaluating their suitability and productivity are essential to ensure the sustainability of this strategic crop (Alnagar and Kadhim)

It has been observed that solar radiation impacts different growth stages, influencing chlorophyll synthesis and transpiration by controlling stomatal opening and closure. Day length plays a role in prolonging vegetative growth and delaying plant maturity and flowering. The growth period is affected by the photoperiod, with a one-hour daily variation (12-15 hours of daylight) causing a change in the growth duration by approximately 10-14 days, the accumulation of heat units, representing the cumulative temperature from planting to maturity, plays a crucial role in determining all the stages required for the plant to complete its growth and maturity (Al-Jubouri et al, 2014), and (Taha, et al 2019).

The study aims to estimate phenotypic variance components, coefficients variations, heritability broad sense, and expected genetic advance of maize genotypes under different planting dates.

Materials and Methods

A field experiment was conducted during the autumn season of 2023 at the Agricultural Research Station in the College of Agriculture at the University of Kirkuk, located at a longitude of 44.3395 degrees east and latitude of 32.3895 degrees north, approximately 6 km from the center of Kirkuk. Two factors were studied: the first was different planting dates (July 5, July 15, and July 25), and the second was nine genotypes of Maize. The experiment was conducted in a split-plot design with randomized complete blocks design with three replications, where the main plots represented the planting dates and the subplots represented genotypes. Soil preparation included plowing with a plow, soil leveling and smoothing. The land was then divided into three main experimental units for each replication. Each experimental unit was 3 meters long, with a distance of 0.75 meters between rows and a distance of 0.20 meters between plants. The experimental field was fertilized by adding triple superphosphate (P2O5 46%) at a rate of 200 kg/ha, applied all at planting. Nitrogen fertilizer, represented by urea (46% N), was applied at a total of 300 kg/ha in three increments: the first was applied during the second week after planting, the second when the plants reached 30 cm tall after the fifth week of planting, and the third at flowering in the seventh week of planting (Ahmed, 2023), and (Al Bayati et al 2023).

hree seeds were placed in each hole and reduction to one plant per whole one week after germination. The crop was irrigated and weeds were manually removed several times during the growing season as needed. The corn borer pest (*Helicoverpa zea*) was controlled using granulated diazinon (10%) at a rate of 6.00 kg/ha, with the first application at 25 days old, followed by a second application one week after the first.

2.2.1 Growth Stages:

Heat Accumulation for Different Growth Stages (Brown and et 1993):

1. V1 Stage: The average number of days from planting to the appearance of the lower ear was calculated for five pits per experimental unit and then multiplied by the average daily growing degree temperature.
2. V2 Stage: The average number of days from planting to the curling of the second leaf around the plant's stem was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.
3. V4 Stage: The average number of days from planting to the appearance of four leaves was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.
4. V6 Stage: The average number of days from planting to the appearance of six leaves was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.
5. V8 Stage: The average number of days from planting to the appearance of eight leaves was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.
6. V10 Stage: The average number of days from planting to the appearance of ten leaves was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.
7. V12 Stage: The average number of days from planting to the appearance of twelve leaves was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.
8. V14 Stage: The average number of days from planting to the appearance of fourteen leaves was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.
9. VT Stage: The average number of days from planting to reaching the male fertilization stage was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.
10. RT Stage: The average number of days from planting to reaching the female fertilization stage was calculated for five holes per experimental unit and then multiplied by the average daily growing degree temperature.

Statistical Analysis and Genetic Parameters

The genetic, environmental, and phenotypic variances and heritability broad-sense for each planting date were estimated using the SPAR 2.0 genetic analysis program, according to (Singh and Chaudhary ,1985).

Heat Accumulation: It was calculated as follows:

- Heat Accumulation = Average Daily Temperature – Base Temperature
- Average Daily Temperature = (Maximum Temperature + Minimum Temperature) / 2
- Base Temperature for maize = 13 °C

This is calculated for each day, and then the temperatures are summed from planting to the stage of 50% female flowering (Emergence 2023)

Alam, Mohammad Ashraful, Marufur Rahman, Salahuddin Ahmed, Nasrin Jahan, Mohammad Al-Amin Khan, Mohammad Rafiqul Islam, Amnah Mohammed Alsuhaibani, Ahmed Gaber, and Akbar Hossain. 2022. "Genetic Variation and Genotype by Environment Interaction for Agronomic Traits in Maize (Zea Mays L.) Hybrids." *Plants (Basel, Switzerland)* 11 (11). https://doi.org/10.3390/plants11111522.

Emergence, Germination. 2023. "MAIZE HEAT UNITS – DECEMBER 2023 BY JON MYHILL – MGA AGRONOMIST," no. December.

Rasheed, Adnan, Muhammad Ilyas, Taj Naseeb Khan, Athar Mahmood, Usama Riaz, Muhammad Bilal Chattha, Najla Amin T Al Kashgry, et al. 2022. "Study of Genetic Variability, Heritability, and Genetic Advance for Yield-Related Traits in Tomato (Solanum Lycopersicon MILL.)." *Frontiers in Genetics* 13:1030309. https://doi.org/10.3389/fgene.2022.1030309.

Results and discussion

1. Genetic Parameters for the Studied Traits at the Planting Date of July 5

Table (1) shows the values of the studied genetic parameters for the date of July 5. It reveals that the genetic variance was higher than the environmental variance for all studied traits and heat accumulation stages, with the genetic variance value being greater. The genetic coefficient of variation was moderate in the heat accumulation stages V2 and V4, with values of 11.974 and 10.279, respectively. For the remaining traits and heat accumulation stages, the values of the genetic coefficient of variation were all low. In contrast, the phenotypic coefficient of variation was moderate in the heat accumulation stage VE. The values of the genetic and phenotypic coefficients of variation varied depending on the genetic compositions, which is attributed to the differences in the values of genetic and phenotypic variance. These values were low to moderate for all traits, indicating the importance of studying the interaction between genetic and environmental factors. The high values of genetic variance provide an opportunity for plant breeders to select and improve yield traits (Baktash et al., 2000).

Table 1. Genetic Parameters of the Studied Traits for Maize Genotypes at the First Planting Date (July 5)

Growth stages	$\sigma^2 G$	$\sigma^2 E$	$\sigma^2 P$	$CV\ P$	$CV\ G$	$H.B.S\%$	ΔG	$\Delta G\%$
V1	1291.61	250.96	1542.58	16.91	15.47	0.8373	67.74	29.17
V2	2136.82	979.91	3116.74	13.50	11.18	0.6855	78.84	19.07
V4	2620.98	893.91	3514.90	11.90	10.27	0.7456	91.06	18.28
V6	2077.94	1550.38	3628.33	8.18	6.19	0.5727	71.06	9.65
V8	3256.76	2270.68	5527.44	8.23	6.32	0.5891	90.23	9.99
V10	6323.11	2582.15	8905.26	8.63	7.27	0.7100	138.03	12.62
V12	6069.99	2163.12	8233.11	6.91	5.93	0.7372	137.80	10.50
V14	7237.99	1414.64	8652.64	6.26	5.72	0.8365	160.29	10.79
VT	21813.54	1022.83	22836.37	8.48	8.29	0.9552	297.35	16.69
RT	13180.21	736.21	13916.43	6.39	6.22	0.9470	230.15	12.48

The heritability values were moderate in the heat accumulation stages V6 and V8, with values of 0.571 and 0.572, and 0.589, respectively. This is attributed to the higher value of environmental variance compared to the lower value of genetic variance influencing these traits. The close values of genetic and environmental variance indicate that traits can be improved by implementing a breeding program while simultaneously enhancing environmental conditions, such as fertilization, irrigation, and plant density, among others (Baktash et al., 2000) (Rasheed et al. 2022)

The expected genetic advance, as a percentage, ranged from high to moderate and low. It was high in the heat accumulation stages (VE, V2, V4, V10, V12, V14, VT, and RT), with values of 29.175, 19.077, 18.283, 12.629, 10.505, 10.795, 16.696, and 12.483, respectively. The variance in the average phenotypic value among the selected genotypes compared to the average value of the genetic compositions before selection suggests that selecting for these traits could lead to the recurrence of desired alleles for the aforementioned traits, indicating a high response to selection, which would result in an increased value of expected genetic advance. In contrast, the expected genetic advance was low in the heat accumulation stages V6 and V8, with values of 9.659 and 9.995, respectively. From this, onclude that the values of selection response (expected genetic advance as a percentage) were moderate for most traits, indicating that substantial improvement is expected through selection, in addition to the expected genetic advance (Baktash et al., 2000).

2. Genetic Parameters for the Studied Traits at the Planting Date of July 15.

It is evident from Table (2) that the heritability values ranged from high to moderate. The values were moderate in the heat accumulation stages V6 and V14, reaching 0.596067 and 0.506256, respectively. In contrast, for the remaining heat accumulation stages, the heritability was high in the stages VE and V2, followed by V4, V8, V10, V12, VT, and RT, with values of 0.642463, 0.667800, 0.687970, 0.690651, 0.680936, 0.698436, 0.955366, and 0.934669, respectively.

Table 2. Genetic Parameters of the Studied Traits for Maize Genotypes at the second Planting Date (July 15)

Growth stages	$\sigma^2 G$	$\sigma^2 E$	$\sigma^2 P$	$CV\ P$	$CV\ G$	$H.B.S\%$	ΔG	$\Delta G\%$
V1	423.95	235.93	659.89	13.32	10.67	0.6424	33.99	17.63
V2	1139.23	566.71	1705.95	11.58	9.46	0.6678	56.81	15.94
V4	1838.11	833.68	2671.80	10.68	8.85	0.6879	73.25	15.13
V6	2280.53	1545.43	3825.96	9.40	7.25	0.5960	75.95	11.54
V8	3680.81	1648.66	5329.48	8.84	7.34	0.6906	103.86	12.58
V10	4351.29	2038.86	6390.15	7.81	6.45	0.6809	112.13	10.96
V12	4924.73	2126.34	7051.08	6.88	5.75	0.6984	120.81	9.89
V14	1721.65	1679.10	3400.75	4.08	2.90	0.5062	60.81	4.25
VT	13766.08	643.14	14409.22	7.04	6.88	0.9553	236.24	13.86
RT	9890.93	691.34	10582.28	5.82	5.63	0.9346	198.06	11.21

The expected genetic advance, expressed as a percentage, varied from moderate to low. It was moderate in the heat accumulation stages VE, V2, V4, V6, V8, V10, VT, and RT, with values of 17.6338, 15.9426, 15.13852, 11.54445, 12.58205, 10.96859, 13.86235, and 11.21755, respectively. However, it was low in the heat accumulation stages V12 and V14, with values of 9.899639 and 4.256212, respectively.

3- Genetic Parameters for the Studied Traits at the Planting Date of July 25

It is evident from Table (3) that the phenotypic coefficient of variation in the heat accumulation stages ranged from moderate to low. The values were moderate in the stages VE, V2, V4, V6, V8, and V10, with values of 12.037549, 15.201215, 14.972139, 14.530550, 12.910038, and 11.894630, respectively. In contrast, the values were low in the stages V12, V14, VT, and VR, with values of 8.953783, 7.157031, 5.773889, and 4.103313, respectively.
The genetic coefficient of variation ranged from moderate to low in the stages V2, V4, V6, V8, and V10, with values of 11.963650, 13.569866, 12.664318, 11.019901, and 10.597348, respectively. In the remaining stages, the values were low in VE, V12, V14, VT, and VR, with values of 8.143178, 8.005271, 6.244971, 5.661921, and 3.843044, respectively. The heritability values for the heat accumulation stages were high for all stages except for one, which was moderate, with a value of 0.457627. The expected genetic advance, expressed as a percentage, was moderate in the heat accumulation stages except for stage VR, which had a value of 7.414456. These results are consistent with findings from several researchers, including Jilo et al. (2018), Abe et al. (2019), Fisseha et al. (2020), and Al-Ghi (2021).

Table 3. Genetic Parameters of the Studied Traits for Maize Genotypes at the Third Planting Date (July 25)

Growth stages	$\sigma^2 G$	$\sigma^2 E$	$\sigma^2 P$	$CV\ P$	$CV\ G$	$H.B.S\%$	ΔG	$\Delta G\%$
V1	170.66	202.26	372.92	12.03	8.14	0.4576	18.20	11.34
V2	1497.70	920.29	2417.99	15.20	11.96	0.6193	62.74	19.39
V4	3818.39	829.93	4648.33	14.97	13.56	0.8214	115.37	25.33
V6	5965.75	1887.79	7853.54	14.53	12.66	0.7596	138.67	22.73
V8	7420.26	2763.74	10184.00	12.91	11.01	0.7286	151.47	19.37
V10	10505.82	2729.59	13235.42	11.89	10.59	0.7937	188.11	19.44
V12	8650.46	2171.36	10821.83	8.95	8.00	0.7993	171.29	14.74
V14	7267.89	2277.93	9545.82	7.15	6.24	0.7613	153.23	11.22
VT	8321.06	332.36	8653.42	5.77	5.66	0.9615	184.26	11.43
RT	4176.76	584.89	4761.66	4.10	3.84	0.8771	124.68	7.41

Conclusions

The study on the genetic parameters of maize genotypes across different planting dates provides valuable insights into the influence of heat accumulation on maize growth and productivity. The results indicate that early planting dates, particularly July 5, exhibit high heritability rates during initial growth stages, suggesting a strong potential for genetic improvement through selective breeding. Conversely, later stages, especially V6 and V8, show lower heritability and genetic advance values, indicating a reduced capacity for selection success at these times.

The findings underscore the importance of understanding the interaction between genetic and environmental factors in maize cultivation. The moderate to high genetic variance observed across most traits suggests that there is significant potential for enhancing yield traits through targeted breeding programs. However, the study also highlights the necessity of optimizing environmental conditions—such as fertilization and irrigation—to maximize genetic gains.

Overall, this research contributes to the body of knowledge necessary for improving maize production in Iraq, addressing existing challenges related to hybrid varieties and agricultural practices. Future studies should focus on further refining these genetic parameters and exploring additional environmental factors that may influence maize performance under varying climatic conditions.

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تأثير مواعيد الزراعة والتراكم الحراري وتقدير المعالم الوراثية في اداء تراكيب ور اثية من الذرة الصفراء

Zea Maya L.

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الخلاصة

تلخص التجربة الحقلية التي أجريت في كلية الزراعة بجامعة كركوك خلال الموسم الخريفي لعام 2022-2023 إلى دراسة تأثير التراكم الحراري على نمو وإنتاجية تسعة تراكيب وراثية من الذرة الصفراء عبر ثلاثة مواعيد زراعية مختلفة (5 يوليو، 15 يوليو، و25 يوليو). استخدم تصميم الألواح المنشقة بقطاعات عشوائية بثلاث مكررات لتحليل تأثير المواعيد والتراكيب على مراحل التجميع الحراري المختلفة، بهدف تقدير معاملات التوريث، الاختلاف الوراثي، الاختلاف المظهري، والتحسين الوراثي المتوقع لكل مرحلة من مراحل النمو. أظهرت النتائج تباينًا ملحوظًا في التأثيرات الحرارية بين المواعيد المختلفة، حيث تبين أن الموعد الأول (5 يوليو) يتميز بمعاملات توريث وتحسين وراثي مرتفعة في مراحل التجميع الحراري المبكرة (مثل *VE* و*V2* و*V4*) مما يشير إلى إمكانية تحسين السمات الوراثية عبر الانتقاء في هذه المراحل، بينما كانت القيم منخفضة في مراحل مثل *V6* و*V8*. في الموعد الثاني (15 يوليو)، كانت قيم التوريث عالية في معظم المراحل، مما يدل على تأثير كبير للعوامل الوراثية، فيما كانت قيم التحسين الوراثي معتدلة إلى عالية في المراحل المبكرة، ومنخفضة في المراحل اللاحقة مثل *V12* و*V14*. أما في الموعد الثالث (25 يوليو)، فقد كانت قيم معامل الاختلاف الوراثي والمظهري متوسطة في معظم المراحل، مما يعكس تباينًا وراثيًا ومظهريًا ملحوظًا. كانت قيم التوريث مرتفعة في جميع المراحل تقريبًا، باستثناء المرحلة الأخيرة، مما يشير إلى تأثير كبير للعوامل الوراثية، فيما كانت قيم التحسين الوراثي المتوقع متوسطة، مما يدل على إمكانية تحسين الصفات الوراثية في بعض المراحل. تشير هذه النتائج إلى أن المواعيد الزراعية المختلفة تؤثر بشكل كبير على

التراكيب الوراثية للذرة، حيث يظهر الموعد الأول كأفضل موعد زراعي من حيث تحسين السمات الوراثية، بينما تظهر تأثيرات متباينة في المواعيد اللاحقة. تعتمد إمكانية تحسين السمات الوراثية على التفاعل بين التراكيب الوراثية والتراكم الحراري، مما يتطلب اختيار مواعيد زراعية مناسبة وتراكيب وراثية ملائمة لتحقيق إنتاجية مثلى.

الكلمات المفتاحية : مواعيد الزراعة ، التراكم الحراري ، المعالم الوراثية ،التراكيب الوراثية ، الانتاجية الزراعية.