COMBINING ABILITY AND GENE ACTION FOR SOME MAIZE INBRED LINES USING HALF DIALLEL CROSSING AT TWO LOCATIONS DURING TWO SEASONS

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ABSTRACT

This study was aimed to determine combining ability among some maize (*Zea mays L.*) inbred lines. The crossing was carried out at Kalar Crop Research Center in the spring season (2020). The experiment was conducted at two sites, one of which depends on groundwater and the other on surface water (Kalar\ Sulaimani and Khanaqin\ Diyala) respectively. (Kalar Technical Institute and Khanaqin) in full (2020), and spring seasons (2021). The crosses were conducted using a randomized complete block design with three replications. The results indicated significant differences for all agronomic traits. The genotypic mean squares were highly significant for (3HKW and t.ha^{-1}), and gca was highly significant for (3HKW), but the sca was highly significant for (PH; and t.ha^{-1}) at all environments. The mean performance of minimum days required in fall to reach DTT and DTS; by the cross (1 x 4) in Kalar. But; in the second location by the cross (4 x 5). The highest values for NKPR were recorded by the cross (3 x 5) in the spring season in both locations. Differed the heterosis in all environments for all studied traits.

Keywords: Heritability, maize, yield, Genetic parameters, heterosis.

***Part of Ph.D. dissertation for the first author.**

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القدرة على الائتلاف والفعل الجيني لبعض السلالات في الذرة الصفراء بأستعمال التضريب التبادلي النصفي لموقعين خلال موسمين

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المستخلص

تم إجراء التهجين في مركز أبحاث كلار في الفصل الربيعي (2020),واجريت الدراسة في موقعين يمثلان بيئتين مهمتين لمحصول الذرة الصفراء، أحدهما يعتمد على المياه الجوفية والآخر يعتمد على المياه السطحية (كلار/ السليمانية وخانقين/ ديالى) بالتتابع. (المعهد التقني كلار وضواحي خانقين) لموسم الخريفي من نفس العام والموسم الربيعي لعام (2021). لتحديد القدرة على الائتلاف لحاصيل الحبوب ومكوناته لعشرة الهجن من الجيل الاول وابائيهم الخمسة للذرة الصفراء .زرعت جميع التراكيب الوراثية في تصميم القطاعات العشوائية الكاملة بثلاث مكررات في موقعين خلال موسمين (الخريف و الربيع). أشارت النتائج إلى وجود اختلافات كبيرة لجميع الصفات المدروسة بدرجات متفاوتة للسلالات و gca و sca للصفات المدروسة في جميع البيئات. كانت متوسط المربعات العالية معنوية في جميع البيئات للتراكيب الوراثية في الصفتين (3 HKW و $t.ha^{-1}$) ، وكان gca عالية المعنوية للصفة (HKW3) ، لكن sca كانت عالية المعنوية في (PH و $t.ha^{-1}$). بالنسبة لمتوسط الصفات المدروسة، الحد الأدنى لـ DTT و DTS في الموسم الخريف للهجين (1 × 4) في كلار. ولكن في المنطقة الثاني كانت للهجين (4 × 5). أعلى قيمة NKPR سجلها الهجين (3 × 5) في الموسم الربيعي في كلا الموقعين. لكن الأب (1) هي أعلى قيم لـ NRPE في الموسم الربيعي في كلا الموقعين.

الكلمات المفتاحية: نسبة التوريث، الذرة الصفراء، الانتاج, المعالم الوراثية، القوة الهجين.

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INTRODUCTION

In maize (*Zea mays L.*) breeding combining ability of inbred lines is special and powerful tool for studying and comparing the potential usefulness of an inbred line to fit in crosses with several inbred lines or any one of the inbred lines for revealing desirable attributes in hybrid combinations and to determine the nature of gene action (21). Global; climate change and variability in environmental conditions are expected to cause many vital stresses that negatively affect maize production (28) In Iraq. The highest cultivated area using this crop reached 55 thousand dunums and produced 63.3 thousand tons of grain with an average yield of (4535.2) kg/ha. (13). The continued genetic progress in breeding Programs maize depends on the formation of new, unfamiliar consortia to obtain genetic parameters which have new traits and desirable for plant breeders. Crop yield is influenced by the direct impact of weather and environmental conditions on plant growth and development during growing period of a crop. The primary environmental conditions that influence plant developments are photoperiod and temperature, but modern maize hybrids are less dependent on photoperiod and respond more to temperature (34). A study by Abera et.al (3) revealed up to 250% high parent heterosis in maize hybrids. Additionally; hybrids can tolerate different stresses that are biotic and abiotic such as drought, salinity, diseases; and pests, than open-pollinated genotypes. Recently, farmers have also been using the single-cross hybrids as they are superior yielding hybrids to three-way and double-cross hybrids. Hybridization; of inbred lines between differing heterotic groups results in higher heterosis than hybridization within the same heterotic group. Varieties; of yellow corn differ according to their genetic stability, while some cultivars of yellow corn that give a similar appearance when tested in a specific place in a specific season, may give a completely different appearance when tested in different places for several seasons, and some genetic structures may give a regular appearance in different environments(7). The; only way to increase production is vertical expansion by raising the yield per unit area through Improving and developing various production resources and relying on modern technology in the cultivation and management of the crop, the development of varieties and hybrids superior in the quantity and quality of production and adapted to local conditions and tolerant of varying environmental conditions. Therefore; the research aims to study the genetic stability of grain yield and identify genetic patterns that combine high grain yield and their stability across the studied environments (20). Crossing a line to several others provides the mean performance of the line in all its crosses. Combining ability or productivity in crosses is defined as the cultivars or parents' ability to combine among each other during the hybridization process such that desirable genes or characters are transmitted to their progenies. In; another definition, combining ability estimates the value of genotypes based on their offspring performance in some definite mating design (9). The; broad genetic base provides opportunities to expand intrapopulation interline hybrids (46). The; phenomenon of heterosis provides a criterion for the selection of superior crosses involved in the breeding program. Different types; of heterosis viz., relative heterosis, heterobeltiosis, and standard heterosis explain the superiority of F_1s over the mid parent, a better parent, and standard check, respectively. The magnitude of heterosis provides a basis for genetic diversity and acts as a guide in choosing desirable lines and cross combinations (40). This study was aimed to determine combining ability among maize inbred lines (5).

MINERALS AND METHODS

The cross-breeding was carried out in the Kalar Crop Research Center during the spring season (2020), and the study was conducted in two research sites representing the most critical cultivation of corn crops with different agricultural environments, one of which depends on groundwater and the other depends on surface water (Kalar and Khanaqin) respectively. (Kalar Technical Institute and outskirts of the Khanaqin) district for the fall seasons of the same year and the spring season (2021). Five; inbred lines of maize (*Zea mays L.*) were crossed by half diallel mating design to produce ten; F_{1s} and five parents progenies were tested, namely (1= 844, 2= zp-595, 3=

Sym-5, 4=834, 5= DKcc). Each; experiment was conducted using a randomized complete block design (RCBD), with 0.75 $_{m}$ inter-row spacing and 0.25 $_{m}$ Intra row spacing with three replications in both locations and seasons. All; agronomic practices weeding were followed according to recommendations for maize cropping at each site. At; the same research farm. The; Data was recorded on the date to tasseling (DTT); date to silking (DTS); plant height (PH $_{cm}$); ear height (EH $_{cm}$); ear length (EL $_{cm}$), number kernels per row (NKPR); number of rows per ear(NRPE); 300 kernels weight (3HKW$_{gm}$); Grain yield ton/ha (t.ha^{-1}); and oil percent (Oil%). Standard; heterosis against the commercial check hybrid was calculated and tested as per methods given by (42), the significance of heterosis was tested using General and specific combining ability (gca; and sca;) effects were estimated using Griffing's model 1 (fixed genotype effects), method 4 (crosses only) The following statistical model (22). Using the lowest significant difference (LSD) in a probability level of (5%) for comparison between the arithmetic means of the studied characteristics (44).

RESULTS AND DISCUSSION

1- Kalar location

Increasing the DTT; and DTS; period gives a better opportunity to form a wider leaf area, which is reflected in the increases in the yield of yellow corn as a result of the large size of the source that feeds the estuary, and decreasing this period provides the opportunity for the plant to flower earlier during the days with moderate temperatures that guarantee a high fertility rate. The; number of grains in the yellow plant corn (5). Showed; analysis of variance to test the significance of differences among the genotypes revealed highly significant differences for most of the traits: this is evidence of good diversity in the genetic material chosen for the study (26). Data; represents in Table (1) illustrate the mean squares of genotypes, gca, and sca of studied characters in both seasons fall the Left values, and spring the Right values. The; genotypic mean squares were highly significant for PH; EL; NKPR; 3HKW; and t.ha^{-1}. But it was significant for DTT, while did not significant for the others at fall season. In; the spring season the mean square due to genotypes was highly significant for all traits except EH; and significant EL and it wasn't significant for NRPE and Oil%. The; mean squares due to gca were highly significant for DTT; PH; EL; and 3HKW, but significant for EH; NKPR; and t.ha^{-1}. While; did not significant for the others of the fall season. In; the spring season, the mean squares due to gca were highly significant for all traits except NRPE; and Oil%, which did not significant. Regarding; the mean squares for sca in fall season, it was highly significant for PH; and t.ha^{-1}, but was significant for EL; NKPR; and 3HKW, and non-significant for the others. In; the spring season, the sca mean squares for DTT; PH; NKPR; and t.ha^{-1} were highly significant, while it was significant for 3HKW; and did not significant for the others. Many researchers have suggested grain rows per ear as the primary selection criterion. (16; 45). Linear effect environments revealed high significance in all studied traits, which means the responses to the multi environments controlled by genetic part (10). With; a standard tester, differences among the crosses are generally assumed to arise from genetic variability among the plants of inbred lines crossed on its. In Table (2),

Table 1. Mean square (analysis of variances) for yield and yield components of maize in (fall, spring) seasons of Kalar

S.o.V	Rep.		Genetic		gca		sca		Error	
d.f	2		14		4		10		28	
DTT	1.4	31.667	14.466*	33.228**	33.68**	77.466**	6.780^{NS}	15.533**	5.78	4.738
DTS	0.822	25.267	12.460^{NS}	40.771**	19.690^{NS}	93.580**	9.568^{NS}	19.647^{NS}	8.179	11.481
PH$_{(cm)}$	648.593	892.763	1189.79**	658.485**	1211.462**	888.102**	1181.121**	566.639**	127.116	169.072
EH$_{(cm)}$	345.16	229.721	132.008^{NS}	230.452*	244.899*	516.088**	86.851^{NS}	116.197^{NS}	73.712	84.356
EL$_{(cm)}$	3.382	1.551	11.978**	14.325*	16.318**	25.821**	10.242*	9.726^{NS}	3.974	5.474
NKPR	16.346	4.269	121.984**	69.610**	131.766*	136.776**	118.071*	42.744**	39.662	11.505
NRPE	0.385	0.662	1.866^{NS}	2.727^{NS}	1.496^{NS}	4.025^{NS}	2.014^{NS}	2.208^{NS}	1.115	1.879
3HKW	1.028	256.447	378.386**	262.829**	762.984**	398.646**	224.547*	208.503*	98.584	77.984
t ha^{-1}	3.394	5.039	17.933**	11.030**	6.678*	9.686**	22.434**	11.567**	2.136	2.204
Oil%	1.464	0.165	1.129^{NS}	0.555^{NS}	0.645^{NS}	0.977^{NS}	1.322^{NS}	0.387^{NS}	0.618	0.37
F.tab $_{.(0.05)}$			2.064		4.074		2.19			
F.tab $_{(0.01)}$			2.795		2.714		3.032			

indicates to the mean performance of diallel crosses and their parents for different characters in fall (the upper values), and spring season (the lower values). The minimum days required to reach DTT; and DTS; was (46.000 and 47.667) days respectively recorded by the cross (1 x 4) in fall, while the maximum DTT; and DTS; were (78.333 and 81.000) days respectively recorded by the cross (3 x 5) in spring season. The; highest PH; reached (209.556cm) by the cross (1 x 4) during the fall season, but the lowest PH; was (143.889cm) recorded by parent (1) during the spring season. The; highest values for EH; were (90.778cm) recorded by the cross (4 x 5) at spring season, while the lowest was (52.000cm) recorded by the cross (3 x 4) in fall. The; cross (2 x 4) produced the maximum LE; reached (23.444cm) in fall, while the parent (3) showed the lowest value for EL; NKPR; t.ha^{-1} at spring reached (14.558cm, 28.111 kernels, and 1.134 t.ha^{-1}, respectively. Maximum NKPR; NRPE; and t.ha^{-1}, produced by the cross (2 x 5) with (51.889) in fall, (17.111) in spring, and (12.040) t.ha^{-1}, at fall respectively. The maximum weight of 3HKW was (106.007g) recorded by the cross (4 x 5) in fall, but the lowest weight was (56.358g) recorded by the cross (3 x 5) at spring. The; Oil% was restricted between (1.870 to 4.418%) for the cross (3 x 5) in fall and parent (2) in spring. Improving ear yield and quality is a crucial objective in the sweet corn breeding program (18; 43). Previous; workers indicated the significance of the parent middle heterosis for most of the F1s crosses for grain yield and its components traits (30). The; specific combining ability for grain yield per plant showed no apparent relationship with performance means and heterosis based on better parent and commercial variety (11). Based; on mid-parents and specific combining ability, the standard heterosis for diallel crosses is estimated as the percentage (F$_{1S}$.) deviation from mid-parental values represented In Table (3) for both seasons in Kalar location. The; highest positive heterosis for DTT; and DTS; and the highest positive heterosis for PH; and NRPE; recorded by the cross (1 x 4),

Table 2. Mean performance of half diallel crosses for different characters in (fall, Spring) season of Kalar

Parents and Crosses	DTT	DTS	PH(cm)	EH(cm)	EL(cm)	NKPR	NRPE	3HKW	t.ha^{-1}	Oil%
1	52.000	53.333	145.389	63.111	20.778	39.000	15.556	68.598	3.783	2.848
	70.333	73.333	143.889	61.444	22.222	46.111	16.000	60.042	2.371	3.668
1 x 2	50.333	52.667	202.000	71.444	21.000	38.222	14.222	70.737	6.144	2.941
	71.333	74.000	175.889	76.778	20.000	41.222	15.111	62.054	4.954	3.900
1 x 3	48.667	50.333	173.111	55.445	20.556	39.222	14.444	77.108	5.950	3.933
	74.333	75.667	182.000	68.778	20.556	38.444	15.111	82.927	5.544	3.697
1 x 4	46.000	47.667	209.556	70.667	22.778	43.000	16.000	91.540	8.089	2.318
	72.667	75.000	191.889	88.556	20.556	42.111	15.111	75.440	4.038	3.594
1 x 5	48.667	49.333	201.444	59.444	22.667	41.333	14.444	80.615	10.520	4.383
	72.000	72.333	186.222	70.000	23.111	47.778	15.778	75.314	7.237	3.851
2	47.667	49.333	177.889	59.111	18.111	32.222	14.222	91.011	4.540	3.405
	70.333	72.000	175.889	77.778	17.000	34.444	15.556	59.582	3.540	4.418
2 x 3	50.667	52.333	187.111	56.222	18.222	36.833	13.778	77.809	6.709	2.984
	69.667	74.000	188.111	74.667	19.778	42.111	15.556	77.832	5.182	3.105
2 x 4	47.000	48.667	204.889	74.444	23.444	48.444	15.111	84.606	9.510	3.164
	67.667	68.333	194.333	86.111	18.444	35.222	13.556	74.854	6.303	3.535
2 x 5	47.333	49.000	202.778	62.444	23.222	51.889	15.111	81.018	12.040	3.176
	70.333	71.667	197.111	77.222	20.667	42.667	17.111	67.724	6.431	4.069
3	51.667	52.333	160.778	56.390	17.500	28.667	14.000	88.424	5.678	2.587
	77.333	79.667	153.889	64.333	14.556	28.111	13.778	72.820	1.134	3.480
3 x 4	48.000	50.000	166.833	52.000	20.056	35.333	14.889	95.462	7.968	2.644
	68.000	69.000	180.667	73.333	21.444	38.333	14.889	89.183	5.590	3.114
3 x 5	52.667	54.667	182.222	59.556	20.111	40.333	14.889	66.183	3.714	1.870
	78.333	81.000	178.111	83.889	17.222	37.444	13.778	56.358	0.770	2.774
4	46.000	49.333	152.833	67.167	17.556	28.444	13.333	97.681	4.456	3.102
	66.333	68.000	173.889	85.889	19.778	40.111	14.444	80.512	5.395	3.541
4 x 5	46.667	48.667	188.000	62.222	20.444	37.222	13.111	106.007	6.266	2.620
	71.000	72.000	196.222	90.778	20.111	38.444	15.778	70.196	4.880	3.292
5	49.667	50.667	188.444	55.556	21.333	41.333	14.222	84.583	6.512	3.220
	73.333	75.000	180.889	75.000	18.333	37.333	15.556	68.161	2.986	4.108
L.S.D $_{(0.05)}$	4.021	4.782	18.853	14.357	3.333	10.531	1.766	16.603	2.444	1.315
	3.640	5.666	21.743	15.358	3.912	5.672	2.292	14.767	2.483	1.017

Table 3. Standard heterosis values on the parents for the studied traits in (fall, spring)) seasons of Kalar

Crosses	DTT	DTS	PH(cm)	EH(cm)	EL(cm)	NKPR	NRPE	3HKW	t.ha^{-1}	Oil%
1 x 2	1.003	2.597	24.970	16.909	8.000	7.332	-4.478	-11.362	47.653	-5.943
	1.422	1.835	10.007	10.295	1.983	2.345	-4.225	3.749	67.619	-3.536
1 x 3	-6.109	-4.732	13.083	-7.207	7.402	15.928	-2.256	-1.787	25.793	44.719
	0.677	-1.089	22.239	9.364	11.782	3.593	1.493	24.831	216.266	3.435
1 x 4	-6.122	-7.143	40.537	8.486	18.841	27.512	10.769	10.104	96.374	-22.104
	6.341	6.132	20.769	20.211	-2.116	-2.320	-0.730	7.347	3.990	-0.306
1 x 5	-4.262	-5.128	20.686	0.187	7.652	2.905	-2.985	5.255	104.382	44.434
	0.232	-2.472	14.677	2.606	13.973	14.514	0.000	17.492	170.190	-0.949
2 x 3	2.013	2.951	10.499	-2.646	2.340	20.985	-2.362	-13.273	31.317	-0.392
	-5.643	-2.418	14.084	5.082	25.352	34.636	6.061	17.569	121.730	-21.375
2 x 4	0.356	-1.351	23.904	17.906	31.464	59.707	9.677	-10.324	111.435	-2.746
	-0.976	-2.381	11.118	5.227	0.302	-5.514	-9.630	6.863	41.081	-11.155
2 x 5	-2.740	-2.000	10.707	8.915	17.746	41.088	6.250	-7.722	117.884	-4.121
	-2.088	-2.494	10.495	1.091	16.981	18.885	10.000	6.032	97.103	-4.543
3 x 4	-1.706	-1.639	6.395	-15.828	14.422	23.735	8.943	2.589	57.261	-7.058
	-5.336	-6.546	10.237	-2.367	24.919	12.378	5.512	16.326	71.234	-11.280
3 x 5	3.947	6.149	4.359	6.401	3.577	15.238	5.512	-23.491	-39.063	-35.588
	3.982	4.741	6.406	20.415	4.730	14.431	-6.061	-20.048	-62.602	-26.896
4 x 5	-2.439	-2.667	10.174	1.403	5.143	6.688	-4.839	16.323	14.268	-17.107
	1.671	0.699	10.617	12.845	5.539	-0.717	5.185	-5.569	16.448	-13.919
SE	1.077	1.299	3.484	3.319	2.849	5.495	2.009	3.824	16.069	8.252
	1.188	1.203	1.582	2.431	3.123	3.848	1.939	4.118	25.886	3.077

recording(-6.122, -7.143, 40.537, and 10.769%) respectively in fall season. The; highest positive heterosis for EH; was (20.415%) obtained from the cross (3 x 5) in spring. The; cross (2 x4) showed the highest positive heterosis for both EL; and NKPR; reached (31.464 and 59.707%) respectively in fall. The; highest positive heterosis for 3HKW; and t.ha^{-1}, produced by the cross (1x 3) in spring reached (24.831 and 216.266%) respectively. The maximum heterosis value for Oil% was (44.719%) exhibited by the cross (1 x 3) in fall.

Table 4. Genetic parameters of the studied traits in (fall, spring) seasons of Kalar

traits	Ơ^{2}E	Ơ^{2}gca	Ơ^{2}sca=Ơ^{2}D	Ơ^{2}gca/Ơ^{2}sca	Ơ^{2} A	ā	h$_{(n.s)}$	h $_{(B.s)}$
DTT	5.781	1.329	0.333	3.985	2.657	0.501	0.303	0.341
	4.738	3.463	3.598	0.962	6.927	1.019	0.454	0.690
DTS	8.179	0.548	0.463	1.184	1.096	0.919	0.113	0.160
	11.481	3.910	2.722	1.436	7.819	0.834	0.355	0.479
PH$_{(cm)}$	127.116	51.636	351.335	0.146	103.271	2.608	0.178	0.781
	169.072	34.240	132.522	0.258	68.479	1.967	0.185	0.543
EH$_{(cm)}$	73.712	8.152	4.380	1.861	16.304	0.733	0.173	0.219
	84.356	20.559	10.614	1.937	41.117	0.719	0.302	0.380
EL$_{(cm)}$	3.974	0.588	2.089	0.281	1.176	1.885	0.162	0.451
	5.474	0.969	1.418	0.684	1.938	1.210	0.219	0.380
NKPR	39.662	4.386	26.136	0.167	8.772	2.441	0.118	0.468
	11.505	5.965	10.413	0.573	11.931	1.321	0.352	0.660
NRPE	1.115	0.018	0.300	0.060	0.036	4.065	0.025	0.232
	1.879	0.102	0.110	0.931	0.204	1.036	0.093	0.143
3HKW	98.584	31.638	41.988	0.753	63.276	1.152	0.310	0.516
	77.984	15.270	43.507	0.351	30.539	1.688	0.201	0.487
t.ha^{-1}	2.136	0.216	6.766	0.032	0.433	5.593	0.046	0.771
	2.204	0.356	3.121	0.114	0.713	2.960	0.118	0.635
Oil%	0.618	0.001	0.235	0.005	0.003	13.415	0.003	0.277
	0.370	0.029	0.006	5.061	0.058	0.445	0.133	0.147

Data in Table (4) shows some genetic parameters for both seasons in Kalar location. It; was confirmed that the ratio of (Ơ^{2}gcs/ Ơ^{2}sca) was more than one for the traits (DTT) in fall and (Oil %) in spring season, and also the traits (DTS; and EH ;) were more than one in both seasons, unlike the other traits were less than one, Regarding; the values of average degree of dominance, it was found that any traits that were given a high value of (Ơ^{2}gca /

Ơ^{2}sca) more than one, were shown to have a low value of the average degree of dominance less than one. All; traits had a highest value for average degree of dominance more than one except for (DTT) at fall and (Oil %) in spring season and also for the traits (DTS; and EH ;) at both seasons. It was revealed that the inheritance of most traits was controlled by the overdominance gene effect. Heritability; in the narrow season was found to be low for almost all traits, while in the broad sense, it was moderate to high for (PH; EL; and NKPR ;) in the fall season and for (t.ha^{-1}) in both seasons.

2- Khanaqin location

Table 5. Mean square (analysis of variances) for yield and yield components of maize in (fall, spring) seasons of Khanaqin

S.O.V	Rep.		Genetic		gca		sca		Error	
d.f	2		14		4		10		28	
DTT	40.155	33.156	35.641^{NS}	24.984**	73.276*	65.690**	20.587^{NS}	8.701^{NS}	18.227	6.56
DTS	68.289	26.867	67.165*	36.038**	127.300**	83.323**	43.111^{NS}	17.123^{NS}	25.956	11.533
PH$_{(cm)}$	1237.017	517.206	615.804**	190.186*	486.832*	81.934^{NS}	667.393**	233.487**	136.949	76.813
EH$_{(cm)}$)	205.252	231.117	151.649**	99.430^{NS}	302.356**	151.734^{NS}	91.367^{NS}	78.509^{NS}	44.868	60.444
EL$_{(cm)}$	25.956	0.64	33.210**	10.076**	16.747*	13.012*	39.795**	8.902*	5.268	3.454
NKPE	100.652	7.102	113.376**	36.909^{NS}	95.120**	58.484*	120.679**	28.279^{NS}	13.324	21.285
NRPE	2.341	1.464	3.047**	3.367**	3.037*	8.252**	3.051**	1.413^{NS}	0.976	1.017
3HKW	168.153	12.646	992.563**	248.742**	1819.776**	470.136**	661.677*	160.184**	235.237	52.196
t.ha^{-1}	8.596	1.297	7.621**	3.667**	3.223^{NS}	0.491^{NS}	9.380**	4.937**	1.294	0.358
Oil%	1.062	0.582	0.699^{NS}	0.811*	0.764^{NS}	1.279*	0.673^{NS}	0.624^{NS}	0.601	0.377
F.tab $_{(0.05)}$			2.064		2.714		2.19			
F.tab $_{(0.01)}$			2.795		4.074		3.032			

Dina; in Table (5) shows the mean squares of genotypes, gca, and sca for studied characters at both seasons in the second location. In the fall season, the mean squares of genotypes were highly significant for all traits except DTS; which was significant, but DTT and Oil% did not significant. In; the spring season, the genotypic mean squares were highly significant for all characters except PH; and Oil%, which were significant, but did not significant for EH; and NKPE. Concerning; the gca mean squares, it was found to be highly significant for DTS; EH; NKPE; and 3HKW, but it was significant for DTT; PH; EL; and NRPE, while it wasn't significant for the others of the fall season. In; the spring season, it was highly significant for DTT; DTS; NRPE; and 3HKW, but it was significant for EL; NKPE; and Oil%, while not significant for the others. The mean squares due to sca in fall season were highly significant for PH; EL; NKPE; NRPE; and t.ha^{-1}, but it was significant for only 3HKW; while did not significant for the rest. In; the spring season, the sca mean squares were highly significant for PH; 3HKW; and t.ha$^{-1,}$ while it was significant for EL; and did not significant for the rest. This; is consistent with other researchers (29), (35).

Table 6. Mean performance of half diallel crosses for different characters in (fall, Spring) season of Khanaqin

Parents and Crosses	DTT	DTS	$PH_{(cm)}$	$EH_{(cm)}$	$EL_{(cm)}$	NKPR	NRPE	3HKW	$t.ha^{-1}$	Oil%
1	63.333	68.000	106.222	40.889	11.778	24.556	14.000	50.612	1.222	3.950
	82.333	86.000	129.833	62.000	17.222	38.889	16.222	43.183	0.719	2.446
1 x 2	59.667	62.667	121.778	39.222	17.444	37.556	12.000	72.140	2.828	4.109
	79.667	83.000	145.000	60.667	16.778	36.333	14.222	54.959	1.626	3.248
1 x 3	60.000	66.000	137.389	38.667	20.333	37.889	14.000	66.022	3.101	4.025
	80.000	82.667	143.167	61.000	17.444	38.000	15.556	60.845	3.086	2.088
1 x 4	55.333	57.333	138.833	52.333	17.111	35.444	13.556	86.469	5.138	3.988
	78.333	81.000	149.000	75.000	15.000	32.778	15.556	60.306	1.910	3.127
1 x 5	58.667	60.333	147.778	47.556	21.667	42.222	14.222	74.566	5.919	3.920
	81.333	82.667	145.500	64.667	17.889	38.441	16.222	51.405	3.805	3.686
2	60.333	64.333	104.778	33.111	14.889	31.556	11.333	46.207	1.822	4.552
	79.000	83.000	131.833	53.333	13.889	29.667	14.444	46.004	1.513	2.643
2 x 3	58.333	60.000	139.111	42.889	20.667	40.222	13.778	80.397	4.154	3.529
	78.667	80.667	147.000	54.333	14.667	33.111	15.556	51.371	2.670	3.564
2 x 4	56.000	61.000	151.889	54.778	21.000	41.667	14.667	70.932	5.229	3.741
	77.000	79.667	151.000	55.667	17.111	36.778	14.444	55.913	1.408	3.069
2 x 5	56.333	57.667	142.111	41.556	20.778	43.778	13.111	81.397	5.365	2.725
	78.000	81.000	148.500	60.833	16.222	36.778	16.000	55.419	1.892	3.374
3	66.000	72.667	127.111	36.667	13.556	27.000	12.222	56.580	1.493	3.844
	86.000	90.667	128.833	60.500	11.222	28.111	14.222	46.853	0.152	2.540
3 x 4	58.667	59.667	129.889	37.778	18.444	35.667	13.333	100.545	4.100	3.453
	78.000	79.333	153.167	56.333	16.778	31.333	13.111	77.177	2.552	2.516
3 x 5	60.667	64.000	148.444	47.222	20.556	41.000	14.444	66.148	2.575	2.984
	84.333	87.667	139.000	62.667	15.111	35.009	15.322	54.221	3.540	2.826
4	56.000	58.667	128.111	53.444	12.222	25.222	12.000	95.956	2.116	3.850
	75.667	77.333	136.167	63.500	15.111	30.444	12.889	65.918	0.889	2.286
4 x 5	52.333	54.000	143.889	54.667	19.000	36.778	13.333	106.065	4.997	3.049
	76.667	79.667	149.167	57.833	16.778	34.333	14.444	63.457	2.010	3.545
5	62.000	65.000	125.222	39.889	16.222	34.778	14.000	53.878	2.040	3.930
	81.667	83.667	137.000	51.167	13.333	30.111	15.778	44.784	0.343	3.498
L.S.D (0.05)	7.139	8.519	19.569	11.201	3.838	6.104	1.652	25.647	1.903	1.296
	4.283	5.679	14.656	13.001	3.108	7.715	1.686	12.081	1.001	1.027

With a standard tester, differences among the crosses are generally assumed to arise from genetic variability among the plants of inbred lines crossed onto it (19). The; mean performance of diallel crosses and their parents for studied characters represent in Table (6) for both seasons in the Khanaqin location. It; was found that the earlier DTT; and DTS; were recorded by the cross (4 x 5), recording (52.233 and 54.000) days in fall season respectively, while the later DTT; and DTS; shows by parent (3) at spring recording (86.000 and 90.667) days respectively. The; cross (3 x 4) in spring showed the maximum PH; reached (153.167cm), while the parent (2) produced the lowest for each of PH; EH; and NRPE at spring reached (104.778cm, 33.111cm, and 11.333 rows) respectively; maximum values for EH; and EL; was (75.000cm) recorded by the cross (1 x 5) at fall, respectively, but the minimum EL; value was (11.222cm) showed by parent (3) in spring. The; cross (2 x 5) gave the highest NKPR; in spring (43.778), while the lowest NKPR; was (24.556) kernel recorded by parent (1) in fall. Maximum; NRPE was (16.222) rows recorded by both parents (1) and cross (1 x 5) in spring, the highest 3HKW was

(106.065g) showed by the cross (4 x 5) in fall, but the lowest was (43.183g) showed by parent (1) in spring. The; cross (1 x 5) produced the highest t.ha^{-1} in fall reached (5.919 t.ha^{-1}), while the lowest yield was obtained by parent (4) in spring recording (0.889 t.ha^{-1}). The; Oil% value is restricted between (2.088 to 4.552%) for the cross (1 x 3) in spring and (94.552%) for parent (2) in fall, respectively.

Table 7. Standard heterosis values on the parents for the studied traits in (fall, Spring) seasons of Khanaqin

Crosses	DTT	DTS	PH(cm)	EH(cm)	EL(cm)	NKPR	NRPE	3HKW	t.ha^{-1}	O%
1 x 2	-3.504	-5.290	15.429	6.006	30.833	33.861	-5.263	49.020	85.784	-3.349
	-1.240	-1.775	10.828	5.202	7.857	5.997	-7.246	23.244	45.661	27.647
1 x 3	-7.216	-6.161	17.762	-0.287	60.526	46.983	6.780	23.184	128.494	3.286
	-4.950	-6.415	10.696	-0.408	22.656	13.433	2.190	35.157	608.933	-16.265
1 x 4	-7.263	-9.474	18.492	10.954	42.593	42.411	4.274	17.991	207.861	2.261
	-0.844	-0.816	12.030	19.522	-7.216	-5.449	6.870	10.551	137.503	32.132
1 x 5	-6.383	-9.273	27.700	17.744	54.762	42.322	1.587	42.725	262.924	-0.505
	-0.813	-2.554	9.057	14.286	17.091	11.423	1.389	16.874	616.698	24.038
2 x 3	-7.652	-12.409	19.981	22.930	45.313	37.381	16.981	56.433	150.593	-15.932
	-4.646	-7.102	12.788	-4.539	16.814	14.615	8.527	10.644	220.795	37.529
2 x 4	-3.725	-0.813	30.439	26.573	54.918	46.771	25.714	-0.210	165.521	-10.956
	-0.431	-0.624	12.687	-4.708	18.008	22.366	5.691	-0.086	17.235	24.526
2 x 5	-7.902	-10.825	23.575	13.851	33.571	31.993	3.509	62.657	177.838	-35.743
	-2.905	-2.800	10.477	16.427	19.184	23.048	5.882	22.084	103.932	9.885
3 x 4	-3.825	-9.137	1.785	-16.153	43.103	36.596	10.092	31.831	127.214	-10.237
	-3.505	-5.556	15.597	-9.140	27.426	7.021	-3.279	36.872	390.404	4.239
3 x 5	-5.208	-7.022	17.657	23.367	38.060	32.734	10.169	19.771	45.799	-23.232
	0.596	0.574	4.577	12.239	23.077	20.260	2.148	18.339	1331.677	-6.388
4 x 5	-11.299	-12.668	13.596	17.143	33.594	22.593	2.564	41.576	140.469	-21.625
	-2.542	-1.035	9.213	0.872	17.969	13.394	0.775	14.645	226.285	22.584
SE	0.766	1.139	2.515	4.088	3.228	2.386	2.758	6.175	19.196	4.006
	0.591	0.840	0.922	3.183	3.072	2.729	1.525	3.555	126.517	5.536

Data; in Table (7) indicates Khanaqin location maximum negative heterosis for DTT; and DTS; was (-11.299 and -12.668%) respectively recorded by the cross (4 x 5) in fall. The; cross (2 x 4) exhibited the highest positive heterosis for PH; EH; and NRPE; recording (30.439, 26.573, and 25.714%) respectively in fall season. The cross (1 x 3) produces maximum positive heterosis for EL; and NKPR; reached (60.526 and 46.983%) respectively in fall season. The; highest heterosis for 3HKW; was (62.657%) exhibited by the cross (2 x 5) in fall, while for t.ha^{-1} it was (1331.677) produced by the cross (3 x 5) at spring. The; highest positive heterosis for Oil% was (37.529%) obtained from the cross (2 x 3) in spring. Heritability; measures of the degree to which parents transfer heritable characteristics to their progeny (2). Estimates; of additional genetic variance or phenotypic variance could be biased by the following: genotype-environment interactions, dominance variance, and epistatic variance (31). Heritability; value for yield is usually observed as low because of the involvement of a large number of genes and high levels of environmental interaction (48). Some; genetic parameters were present In Table (8) for both seasons in the Khanaqin location. All; traits recorded a low value for the vario of (Ơ^{2}gca/ Ơ^{2}sca), which were less one except (DTT;) in both seasons, (DTS; and NRPE;) at spring season, which recorded a high value of this ratio, unlike the average degree of dominance for most traits were more than one except for those which recorded a high ration of (Ơ^{2}gca/ Ơ^{2}sca), It was observed that the inheritance of most traits in both seasons was under the non-additive gene effect. Heritability; in the narrow sense was found to be low for almost all traits for both seasons, while in a broad sense, it was found to be moderate to high for (PH; EL; and NKPR;) in the fall season and for (3HKW; and t.h^{-1}) in both seasons. The; non-additive gene action was less preponderance in the inheritance of the studied ear traits. Still, additive genes played an important role in it, suggesting that selection of traits having high gca; effects, low sca; effects, and high gca: sca ratio should result in high genetic advance in hybrid progenies, (14; 41; and 15). The; values of variances were varied among studied characters (4). Some; traits were affected more by environmental factors; therefore, we recommend considering the dry minters and crop growth rate as criteria in measuring grains' production ability of maize (6). The; results of this study resemble some of the results of the previous tests and differentiate them from others in some traits among them. .(1; 8; 12; 17; 23; 24; 25; 27; 32; 33; 36; 37;38; 39, 47).

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