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Genetic Parameters Estimates Through Line × Tester Analysis for the Stay Green, Yield and Quality in Maize (*Zea mays* L.).

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Abstract: A field experiment was carried out in the Anbar governorate-Ramadi, located at longitude 043.26 and latitude 033.43 for the fall season 2019 and spring season 2020. Seven inbred lines were crossed with three testers using line × tester mating design to produce 21 single hybrids, the resulting 21 crosses along with ten parents were evaluated during *autumn* 2019 and spring 2020 in a complete randomized block design with three replications. The objectives of this study were to determine gene action, some genetic parameters, and general (GCA), specific combining ability (SCA). The results showed significant differences between the parents and their crosses in all traits. The Inb23 strain outperformed the average individual plant yield, reaching 138.32 g, and the Inb17 × AGR21 hybrid gave the highest mean plant yield 198.28 g, the ZP607 tester gave the highest positive effect for general combining ability in plant yield of 3.097. The components of the variance of the special combining ability were greater than the components of the variance of the general combining ability, and the dominance genetic variance was more important than the additive genetic variance. The narrow sense heritability was low for the number of grains ear and the yield, and was highest in the weight of 300 grains and the number of effective leaves was 14.27% and 13.44%, respectively, resulting in a higher average degree of dominance values more than one for all traits. It is concluded from the study the possibility of using some of the superior parents in their crosses to derive individual hybrids with a specific combine ability to produce high grain yield because most of their characteristics were under the influence of dominance and overdominance, and it is possible to use the character of the number of effective leaves as an selection index to increase the yield.

Keywords: Heritability, Average degree of dominance, gene action, GCA , duration of effective leaf survival

For the purpose of evaluating inbred lines to produce high-yielding hybrids after being crossed with other inbred lines, line x tester test were used , as the value of any genotype is estimated through to know its productivity, its desired characteristics, its genetic behavior and its combining ability, so attention focused

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on choosing suitable strains that have a specific combining ability with genetically different strains to produce hybrids are superior because they express the ability of the strain to produce a distinct hybrid by mating it with another strain (12).

The GCA falls under the influence of the additive gene action, which gives a clear indication of the inbred line of genetic composition, as well as the SCA which falls under the influence of dominance (dominance, over dominance and epistasis).

For the purpose of identifying the genetic behavior, the genetic parameters are estimated by dividing the components of the total genetic variance into the additive and dominant genetic variance and calculating the heritability ratio in its broad and narrow sense, which means the amount of what the productive individuals transfer from a trait to their offspring resulting from it in the first generation because each parent has a general influence to improve a number of the traits as well as the average degree of dominance through which it is possible to know the gene action that controls the traits to determine the appropriate breeding method to improve them, and many researchers focused of this matter in the maize crop (1, 2, 3, 7, 9, 10, 11, 21 ,24,25 and 26) and found that there is a significant effect of the SCA more than the effects of the GCA on the studied traits.

Genetic variation is important for plant breeders as it gives the breeder a wide range in selecting the genetic variation that represents the raw material through which he can select the best genotypes. It was found that the environment is an "important" element to show the characteristics of living organisms (5, 11 and 15).

The grain yield in maize has doubled this century as a result of breeding programs that have caused changes in the rate of photosynthesis as a result of increasing leaf area and prolonging the duration of photosynthesis by delaying the duration of green leaves (4, 8 and 18). The relative leaf expansion rate, the highest leaf area, and the highest leaf aging rate are important factors for estimating the photosynthesis of vegetation, dry matter accumulation, and grain yield, and the genotypes differ in their ability to degradation the proteins of leaves and stems, especially the enzyme Rubisco, which is a photosynthetic enzyme, thus reducing the Photosynthesis shows rapid senescence in the plant, and the importance of leaves to remaining green after flowering in maize is of great importance in seed filling stage, as photosynthesis is at the top at the female flowering stage of the maize and decreases during the period of seed filling stage, and the capacity of photosynthesis decreases when the senescence occurs (17). Al-Maamouri *et al* (9) indicated that the dominant genetic variance was significant higher than the additive genetic variance in the female flowering and the grain yield. Abdul-Hamid *et al.* (4) found that the inbred lines and hybrids showed a significant effect on the number of effective leaves (SG) and the heritability ratios in the broad sense were high. Mutlug *et al* (25) suggested the use of the (line× tester) analysis for combining ability to facilitate the selection of parents of the desired traits that will be used in breeding and improvement programs.

This research aims to analyze the variance of the general and specific combining ability, to provide a base of genetic information on the components of genetic and phenotypic variation, and to study the heritability in a broad and narrow sense in order to infer the best way to develop the yield of maize crop.

MATERIALS AND METHODS

Ten pure lines of maize were used in this study 1-3 testers and 4-10 females whose names are explained in Table 1.

	Pure line	**Name**
Male	1	S.17
	2	AGR21
	3	ZP607
Female	4	M19R
	5	Inb.17
	6	ZM51W
	7	ZM43W
	8	ZM7
	9	ZM12
	10	Inb.23

The research was conducted in a field belonging to a farmer in Anbar Governorate for the autumn 2019 and spring season of 2020 by introducing ten pure lines (4, 5, 6, 7, 8, 9, 10) as females and (1, 2, 3) as males in a Line x Tester mating design proposed by Kempthorne (22) and illustrated by Chaudhary and Singh (27) using a complete randomized block design with three replications. During the two growing seasons, all operations were performed for crop management such as cross plowing, smoothing, leveling, irrigation and weeding according to the scientific recommendations, the field was fertilized with 300 $kg.ha^{-1}$ of di-ammonium phosphate (DAP) added to the soil during the preparation of the land, and 150 $kg.ha^{-1}$ of Urea was split in two equal doses, 75 $kg.ha^{-1}$ applied when plant

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height reached an average of 20 cm and the other 75 $kg.ha^{-1}$ applied at the beginning of flowering. Weed control was done with the application of Proponit after planting and before germination for both seasons. The planting was carried out on furrows, each of 6 m long, with a distance of 0.90 m between furrows and 0.40 m between the plants in order to obtain a chance of more than one ear per plant to benefit for crossing. In the autumn season 2019, pure lines were cultivated with three testers on 11 and 19 July to ensure that flowering is compatible between the pure lines and obtain pollen grains of high vitality for the duration of the crosses. Hybridization was performed between pure lines to obtain the 21 first-generation hybrids, at the end of the season, ears was harvested, seeded, and dried for planting in a comparison experiment, and in the spring season 2020, hybrid seeds were planted with the parents at the end of March. Data were recorded for the studied traits on the basis of individual plants with average of ten plants and border lines were excluded. The characters studied were female flowering (day), the number of active leaves at maturity (SG), the leaf area (cm^2), the number of grains in ear, the weight of 300 grains (gm), the individual plant yield (gm) and protein seed (%)

The GCA and SCA and their variances and heritability were estimated in the broad and narrow sense and the average degree of dominance according to the following mathematical models (27):

Estimate of GCA for pure lines according to following equations:

gi^ = (Xi.. / tr) – (X… / L tr)

As for the GCA of ^ gt for parents used as Testers, their effects were estimated using the equation: gt^ = (X. j. / Lr) – (X… / L tr).

Whereas the effect of SCA for each Sij hybrid was estimated according to the following equation: -

Sij^ = (Xij^ . / r) – (xi.. / tr) – (X . j . / Lr) + (X … / Ltr)

The components of phenotypic variance (σ^2_p), which include additive variance (σ^2_A), dominant variance (σ^2_D) and environmental variance (σ^2_E= Mse), were estimated from the EMS values of the fixed model.

Broad sense heritability ($h^2_{B.S}$), and narrow sense heritability ($h^2_{N.S}$), and average degree of dominance ($\bar{a}$) were estimated as follows:

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$$h^2{}_{\cdot B.S}\ \% = (\sigma^2\ G\ /\ \sigma^2\ P) \times 100$$

$$h^2{}_{\cdot n.s}\ \% = (\sigma^2\ A\ /\ \sigma^2\ P) \times 100$$

$$\bar{a} = \sqrt{\frac{2\sigma 2\ D}{\sigma 2\ A}}$$

Standard errors for combining ability were estimated according to Sing and Chaundry (27):

$$\text{S.E. } (\hat{g}i - \hat{g}j) \text{ Line} = \sqrt{\frac{2mse}{rt}}$$

$$\text{S.E. } (\hat{g}i - \hat{g}j) \text{ Tester} = \sqrt{\frac{2mse}{rL}}$$

$$\text{S.E. } (\hat{S}ij - \hat{S}ik) = \sqrt{\frac{2mse}{r}}$$

Variance component was estimated as follow:

$$\sigma^2 gca = \left[\frac{(Msl-Mse)+(Mst-Mse)+(Mslt-Mse)}{3r}\right]$$

$$\sigma^2\ gca = \left[\frac{1+F}{4}\right] \sigma^2\ A$$

$$\sigma^2\ A = 2\ \sigma^2\ gca$$

$$\sigma^2\ Sca = \frac{M.S(lxt)-Me}{r} = \sigma^2 D$$

Results and Discussion

The mean square was significant for the female flowering traits, the duration of effective leaves, leaf area, number of kernels in ear, weight of 300 grains, and individual plant yield (Table 2). As well as the mean squares for hybrids x parents were also significant for all traits, and the mean squares for hybrids differed significantly and for all traits, as for the mean squares for the pure lines and testers, and the interactions between them, they were also highly significant for all traits. A studies have confirmed the presence of significant differences between genotypes, which allows studying their genetic behavior and studying the GCA and SCA combinations of parents and hybrids respectively (1, 2,3, 5 and 16).

It is noticed by comparing the averages of the trait in the parental strains in Table 3 to that the tester 3 and 2 and pure line 9 took the shortest period for female flowering reached 61.40, 61.70 and 61.20 days respectively. Pure line 4, 10, and

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tester 1 were distinguished by their highest averages of the number of effective leaves (SG), beside that the pure line 10 gave the highest rate in leaf area of 0.4681 cm^2, while the pure line 7 gave the highest average number of kernels per ear and protein seed % , which reached 515.92 grains. While pure line 4 was superior in giving the highest weight of 300 grains, which reached 90.01 gm. As for the plant yield, pure line 10 was distinguished by giving the highest grain yield per plant, which reached 138.32 gm.

Table (2) Analysis of variance for the growth and yield traits.

S.O.V	d.f	Mean square						
		Female flowering (day)	SG (N)	Leaf area (cm^2)	grain per ear	300 grain weight (gm)	Plant yield (gm)	Protein seed %
Rep	2	3.02	0.59	59.67	48.92	19.46	22.11	1.8
Genotype	30	19.84**	2.07*	972.6**	239.2**	23.75**	87.94**	6.65**
Parents	9	6.84**	0.32*	180.73**	54.68**	12.09**	11.97**	9.31**
Parent vs hybrids	1	78.26**	12.16**	1237.0**	452.12**	217.82**	198.62**	3.58*
Hybrids	20	9.84**	1.06**	587.93**	88.02**	9.58**	14.07**	5.37**
Pure lines	6	48.42**	4.86**	955.87**	518.25**	221.73**	256.98**	4.70**
Tester	2	56.52**	2.48**	637.16**	418.41**	168.92**	186.35**	15.79**
Pure lines x Tester	12	21.43**	1.02**	397.96**	308.78**	52.11**	141.08**	2.21*
Experimental error	60	0.595	0.148	98.415	51.59	3.33	9.30	0.81

In hybrids, the hybrid 7 × 1 was distinguished by giving it the lowest number of days for female flowering, reaching 57.30 days, and it did not differ significantly with 4 hybrids, while the hybrid 10 × 2 gave the highest number of days for flowering, reaching 65.20 days. The 5 × 2 hybrid was distinguished by giving the highest average effective leaves of 12.4 leaves, and it did not differ significantly with 3 hybrids , while the 5 × 3 hybrid gave the lowest average of 10.2 leaves. As for the leaf area, the hybrid 1 × 6 gave the highest leaf area of 5767 cm^2, and it did not differ significantly with the 10 × 2 hybrid, which gave 5756 cm^2, and the hybrid 5 × 2 gave the highest average number of grains per ear , which reached 682.32 grains and did not differ significantly with two hybrids, while the two hybrids 10 × 2 and 6 × 1 gave the highest average weight of 300 grains was 101.55 and 100.31 gm, respectively. As for the plant yield, the hybrid 5 × 2 gave the highest grain yield of 198.28 gm, The 5 × 3 hybrid was distinguished by giving the highest Protein seed % effective of 11.2% The superiority of the hybrid was due to the superiority in the number of grains per ear and the number of active leaves

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(SG), and the hybrid did not differ significantly with 3 hybrids. This is in line with what some researchers have found (2, 4, 5 , 6 .7 and 13).

Table 3: Average of studied traits of parents and first-generation hybrids in maize for season 2019

Genotype	Female flowering (day)	SG (N)	Leaf area (cm^2)	grain per ear	300 grain weight (gm)	Plant yield (gm)	Protein seed %
1	66.60	10.9	3819	466.04	84.60	128.42	9.9
2	61.70	10.1	3482	396.77	74.50	99.89	10.2
3	61.40	9.9	3734	331.84	73.03	80.88	10.6
4	65.50	11.1	4512	405.41	90.01	123.17	9.6
5	66.10	10.2	3344	405.48	68.90	95.36	10.5
6	64.60	10.8	4393	327.83	87.30	101.76	8.9
7	65.10	10.7	4085	515.92	74.20	129.51	10.7
8	62.30	10.0	4487	351.62	83.50	98.09	9.9
9	61.20	10.2	4055	474.03	72.01	114.65	8.5
10	60.90	10.8	4681	467.34	88.52	138.32	9.0
4x1	60.40	10.9	4168	671.38	70.23	168.42	9.5
5x1	58.40	10.5	4719	483.69	84.18	138.52	10.4
6x1	60.80	10.3	5767	390.38	100.31	138.41	10.0
7x1	57.30	11.8	4617	613.40	93.74	193.10	9.1
8x1	59.20	11.3	4585	460.35	83.57	149.95	9.7
9x1	62.50	10.9	4128	514.89	85.78	151.78	9.9
10x1	58.20	12.1	4904	628.65	91.11	195.97	8.9
4x2	59.50	11.3	4747	542.84	97.99	179.69	8.7
5x2	63.10	12.4	4084	682.32	86.61	198.28	9.1
6x2	59.40	10.6	4553	485.77	90.56	155.78	10.9
7x2	64.10	10.4	4684	493.70	89.52	149.85	9.9
8x2	62.60	10.5	4192	503.55	92.28	160.44	8.8
9x2	59.70	10.7	4018	671.97	80.50	184.12	9.2
10x2	65.20	10.9	5756	484.84	101.55	173.44	10.3
4x3	61.50	10.6	4822	521.68	86.50	158.43	7.8
5x3	60.60	10.2	5137	411.26	93.00	130.86	11.2
6x3	61.20	10.6	4368	505.69	83.83	148.81	10/8
7x3	58.10	10.4	5018	444.61	92.53	142.21	9.9
8x3	57.50	11.8	5314	587.35	95.81	191.06	8.1
9x3	60.50	11.5	4672	602.86	90.82	182.11	11.0
10x3	62.10	11.1	4471	542.73	85.21	166.38	10.2
L.S.D	1.26	0.63	16.2	11.73	2.98	4.98	1.46

The pure lines differed among themselves in the values of GCA, as the pure lines 4, 5, 10 and the testers 1, 7 gave a significant effect towards early female flowering, while the remaining pure lines and the tester 2 gave a significant effect

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towards delaying the date of flowering (Table 4). The pure lines that gave negative values show the role of the additive gene action towards early flowering, while the pure lines that gave positive values for GCA show the role of the additive gene action in prolonging the growing season. The hybrids also differed among themselves in the values of SCA (Table 5), as the hybrids differed in the effect of SCA as significant differences were found in the SCA, as ten hybrids showed an effect towards early flowering, the lowest was -1.559 and -1.425 for the two hybrids 4 × 1 and 10 × 3 respectively, while the other half of hybrids gave a significant effect towards delay in flowering. Parents who had a positive and significant influence on combining ability gave significant effects in the same direction in the effects of their crosses of SCA, i.e. the occurrence of the dominant gene action, , similar results he found Abd El-Aty *et al* (1), and Kumar *et al* (23).

As for the number of effective leaves (SG), it gave positive and negative effects to the GCA, three pure lines gave a positive significant effect, reaching maximum of 0.48 in pure line 10, while the rest of the pure lines gave negative values. As for the testers, the testers 2, 3 were distinguished by giving positive values. The pure lines that gave positive values are under the influence of additive gene action towards an increase in the number of active leaves (SG), as well as the hybrids differing among themselves by the values of SCA (Table 5). As 9 hybrids were distinguished by their positive, significant and desirable values in the ability of the hybrids to combine, the highest was 0.701 in the 10 × 1 hybrid, i.e. the occurrence of the dominance genes action for these hybrids, while 6 crosses gave negative and significant values of the SCA, similar results obtained by Al-Naggar *et al*. (11).

The leaf area showed positive and negative effects of GCA and SCA, the best effect of GCA in tester 1 was 0.118, as its effect was in the positive direction, and the best positive effect was in the two pure lines, 4, and 6 was 7.402 and 5.050 respectively, this indicates the possibility of benefiting from these parents in increasing the leaf area by transferring this trait to the offspring resulting from the hybridization. Also, the hybrids differed in the values of SCA (Table 5), as five hybrids gave a positive significant effect, the highest of which was 24.970 in the 6 × 1 hybrid, two other researchers (13 and 14) obtained pure lines with GCA for the desired direction and other pure lines with the undesired direction.

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The effect of the GCA of each pure line on the number of grains in ear is shown in Table 4, and that the pure line 5 gave the highest positive value for GCA in the positive direction of 6.770, indicating its participation in the transfer of the trait and its inheritance to its hybrids, pure line 9 gave the lowest negative value of -4.098, Which indicates the low value of the trait and its inheritance to its hybrids. As for the testers, tester 2 gave the highest positive effect towards increasing the number of grains per ear, reaching 3.345, while tester 1 gave a negative effect of -3.085. The values of the positive and negative GCA indicate the participation of the additive and non-additive gene action in controlling this trait. The pure lines that have a positive effect for the combining ability indicates that they have a good tendency towards increasing the trait. As for the pure lines that have a negative effect on the combining ability for the trait, it means that their effect is towards reducing the trait (23). The estimation of SCA for each hybrid presented in Table 5. Eight hybrids outperformed with positive and desirable SCA, the maximum of which was the 5 × 2, and 7 × 2 hybrids 8.921 and 7.899 respectively, while 8 hybrids showed an unwanted negative combination, the maximum of which was 8×3 hybrid with -10.004. The positive or negative values of the SCA effect of hybrids indicate that the average of the trait in these hybrids was higher or lower than the parent's performance rate for the same trait. This is stated by Abu shosha, and Habouh (5) and Tesfaye *et al* (28).

The effect values of GCA (Table 4) for grain weight showed that pure line 5 and 6 higher significant positive effect of 1.672 and 2.130 respectively. Tester 1 also outperformed in giving the highest positive and significant effect of 4.145 in the direction of increasing the average grain weight, which can take advantage of these pure lines to achieve an increase in the average weight of the grain by transferring this trait to the offspring resulting from these crosses when these pure lines were used as parents. While, the pure line 10 and tester 2 gave a significant effect towards reducing the grain weight. The effects of SCA (Table 5) were positive and significant in 7 hybrids, the highest for the 1x6 hybrids was 5.044, while 5 hybrids gave significant effects in the negative direction, with a maximum of -7.283 for the 4 × 1 hybrid. Parents of hybrids that demonstrated positive effects of SCA can be chosen as long as they have the ability to increase the average grain weight of the resulting hybrids. The results are in agreement with Haa (16), who found that the highest effect of grain weight was in the (L1) pure line and that of tester 1 and the highest positive effect for the hybrid (L1xT1). In the individual plant yield trait, the GCA effect results were indicated for each pure line (Table 4). The pure lines 10, 8, and 5 gave the highest positive and significant GCA values in the positive direction, reaching 7.704, 2.091 and 5.168 respectively, which indicates their participation in the transfer of the trait and its inheritance to its hybrids. As for the pure lines, 8, 6, 4, and 9, they gave negative values of -5.006, -7.0555, -1603 and -1.300 respectively, indicating a decrease in the value of the trait and its inheritance to its hybrids. As for the testers, tester 3 gave the highest positive effect towards increasing the yield of plant seeds, reaching 3.097, while tester 1 gave a negative effect of -4.711.The pure lines which showed a positive values for the effect of GCA is evidence of the success of these pure lines in transferring the increase in the plant grain yield to their crosses and vice versa for the pure lines that gave negative values for the effect of their GCA. Nine hybrids were distinguished by desired, significant and positive SCA, with a maximum of 5.657 for the hybrid 1 × 10. Whereas 7 hybrids gave an undesirable negative significant SCA of a maximum of -5.911 for the 6 × 1 hybrid, between (6 and 14.) the presence of positive and negative values for the effect of general and special combinatorial ability on plant yield. Ali et al (8) and Elmyhun et al (17) reported the presence of positive and negative values for the effect of GCA and SCA on plant yield.

The Protein seed %showed positive and negative effects of GCA and SCA, the best effect of GCA in tester 1 was 1.32, as its effect was in the positive direction, and the best positive effect was in the tow pure lines, 4, and 9 was 0.73 and 1.42 respectively, this indicates the possibility of benefiting from these parents in increasing the Protein seed % by transferring this trait to the offspring resulting from the hybridization. Also, the hybrids differed in the values of SCA (Table 5), as four hybrids gave a positive significant effect, the highest of which was 1.83 in the 9 × 2 hybrid, two other researchers .

Table 4 Estimate the effect of the general combining ability (gˆi) for each parent of the studied traits in maize

Genotype	Trait						
	Female flowering(day)	SG (N)	Leaf area (cm^2)	grain per ear	300 grain weight (gm)	Plant yield (gm)	Protein seed %
1	-0.153	-0.30	0.118	-3.085	4.145	-4.711	1.32
2	0.229	0.17	0.024	3.345	-5.661	1.615	-0.53
3	-0.077	0.12	-0.142	-0.261	1.515	3.097	-0.78
SE (gi-gl) tester	**0.238**	**0.12**	**3.061**	**2.216**	**0.563**	**0.941**	**0.36**
4	-0.091	-0.11	7.402	-3.843	-0.334	-5.006	0.73
5	-0.252	0.28	-9.393	6.770	1.672	5.168	-0.73
6	0.441	-0.68	5.050	0.106	2.13	-7.055	0.20
7	0.054	0.32	-5.676	1.117	-0.453	2.091	-0.49
8	0.401	-0.20	0.499	-0.173	0.704	-1.603	-0.90
9	0.100	0.37	0.110	-4.098	-0.330	-1.300	1.42

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10	-0.655	0.48	2.009	0.121	-3.39	7.704	-0.32
SE (gi-gl) line	**0.363**	**0.18**	**4.67**	**3.386**	**0.860**	**1.437**	**0.42**

Table 5: The effect of specific combining ability (Sˆij) for each hybrid of studied traits in maize

Hybrid	Trait						
	Female flowering (day)	SG (N)	Leaf area (cm^2)	grain per ear	300 grain weight	Plant yield (gm)	Protein seed %
4x1	-1.559	0.043	10.820	6.124	-7.283	-1.517	-1.28
5x1	-0.508	0.502	-1.490	-9.301	2.038	0.202	0.17
6x1	0.902	-0.191	24.970	1.051	5.044	-5.911	1.12
7x1	-0.513	0.410	1.448	7.093	2.271	3.231	0.48
8x1	-0.013	-0.787	-2.952	0.138	2.322	-1.001	-0.37
9x1	-0.208	0.102	-0.340	0.382	-3.822	-1.936	-0.12
10x1	0.420	0.701	-4.41	-9.30	-0.520	5.657	0.25
4x2	-0.375	0.321	11.723	-7.442	2.116	4.863	0.40
5x2	1.497	0.416	1.243	8.921	-2.372	3.483	-0.95
6x2	-0.319	-0.897	14.904	0.121	1.087	-4.958	0.85
7x2	0.125	-0.655	-18.145	7.899	-0.450	-3.738	-0.90
8x2	-0.863	-0.099	-2.240	0.107	-2.222	4.087	-0.35
9x2	-0.680	0.103	0.481	-5.128	0.001	-2.952	1.89
10x2	0.308	-0.596	-5.06	-3.06	1.550	-2.96	0.81
4x3	-0.728	0.007	0.204	-5.414	0.533	-5.144	-0.51
5x3	0.791	-0.318	2.976	1.018	2.233	3.091	0.01
6x3	0.236	-0.891	-0.006	6.282	-0.894	-2.352	-0.75
7x3	0.097	0.461	-21.173	-1.886	-1.675	-5.550	-.0.24
8x3	0.015	0.602	-9.929	-10.004	2.123	3.411	-0.91
9x3	0.319	0.357	-12.493	7.038	-0.023	3.387	-0.11
10x3	-1.425	0.407	9.46	5.93	-1.030	3.97	0.02
SE (sij-sik)	**0.630**	**0.310**	**8.12**	**5.36**	**1.49**	**2.49**	**0.73**

Genetic parameters

The variance of GCA, representing the additive genetic variance (σ^2_A), was lower than the SCA variance representing non-additive genetic variance (σ^2_D), and the ratio between GCA to SCA was less than the one (0.043, 0.12, 0.050, 0.022, 0.100 0.022 and 0.06) for the female flowering, the number of active leaves, the leaf area, the number of grains per ear, the weight of 300 grains the plant yield, and Protein seed % respectively, which indicates that the non-additive effect of genes is controlling the expression of these traits, and this is a function of the fact that the

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comparison is for one season and there is no selection in it, This was confirmed by the average degree of dominance, where all the traits had more than one (4.79, 2.92, 4.48, 6.68, 3.16 and 6.69). This was confirmed by the average degree of dominance, where all the traits had values more than one (4.79, 2.92, 4.48, 6.68, 3.16 , 6.69 and 3.92) for studied traits respectively. This was reflected in the value of heritability in a broad sense, as it amounted to 92.70% for female flowering, 70.76% for the number of effective leaves, 52.65% for leaf area, 63.45% for the number of grains in ear, 84.29% for the weight of 300 grains, 83.15% for the plant yield (gm) and 86.15% for the individua Protein seed %

These high values in most of the traits of the degree of heritability in the broad sense are due to the high value of the dominant genetic variance and the low value of the additive genetic variance in their effect on these traits, it means that these proportions of the phenotypic differences in the crosses of these traits are due to the influence of genotype. As for the proportion of heritability in the narrow sense, it was low for all traits, as it reached the highest of 14.27% in the weight of 300 grains and 13.44% in the number of effective leaves. Low heritability in the narrow sense indicates the importance of non-additive gene action in the inheritance of the traits. Similar results were found by Al-Faraji (7), AL Mamarry et al (9), and Al-Naggar et al (10).

Table 6. The genetic parameters values of the studied traits of yellow maize for the autumn season 2019

Parameter	Traits						
	Female flowering (day)	**SG (N)**	**Leaf area (cm^2)**	**grain per ear**	**300 grain weight (gm)**	**Plant yield (gm)**	**Protein seed %**
σ^2 gca	0.302	0.034	4.981	1.92	1.63	0.98	0.29
σ^2 sca	6.95	0.29	99.848	85.73	16.26	43.92	4.46
$\frac{\sigma^2 gca}{\sigma^2 sca}$	0.043	0.12	0.050	0.022	0.100	0.022	0.06
σ^2 A	0.604	0.068	9.962	3.84	3.26	1.96	0.58
σ^2 D	6.95	0.29	99.848	85.73	16.26	43.92	4.46
σ^2 G	7.554	0.358	109.446	89.57	19.26	45.88	5.04
σ^2 E	0.595	0.148	98.415	51.59	3.33	9.30	0.81
σ^2 P	8.149	0.506	207.861	141.16	22.85	55.18	5.85

H^2.b.s%	92.70	70.76	52.65	63.45	84.29	83.15	86.15
% h^2.n.s	7.41	13.44	4.79	2.72	14.27	3.55	9.91
$\bar{a}$	4.79	2.92	4.48	6.68	3.16	6.69	3.92

Conclusion

It is evident from the above that some hybrids are superior in the yield and its components for the comparison season, and it was found that the GCA variance are less than all the components of SCA, and it was noticed that the dominant variance is the main component of the genetic variation in all traits with the presence of the over dominance and the low degree of heritability in the narrow sense for all traits. The increase in the number of effective leaves (SG) led to an increase in the plant yield. Therefore, the best way to improve is to use recurrent selection through genetic reunion to find continuous variations in population under selection and the concentration of those genes through self-pollination with the evaluation of superior hybrids by the tester in breeding and improvement programs for distinct traits.

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