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FIELD PERFORMANCE, HYBRID VIGOR AND ESTIMATION OF SOME OF GENETIC PARAMETERS IN TOMATO (*LYCOPERSICON ESCULENTUM* MILL.)

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Abstract

Seeds of six inbred lines of tomato were planted in the Faculty of Agriculture field, University of Baghdad using full diallel cross to produce 30 diallel and reciprocal hybrids. Seeds of parents, hybrids and control hybrid (Newton) were planted in the field in 2018, using Randomized Complete Block Design (RCBD) with three replicates to study the performance, hybrid vigor and estimating some genetic parameters. A significant differences were found among genotypes (parents and hybrids) for all studied traits. The parents (2 and 4) were superior and gave highest mean in number of fruit per plant, parent 5 was superior in fruit weight, fruit length and fruit diameter. The diallel hybrids (4*5) and (2*3) were superior and gave highest yield and highest hybrid vigor in yield per plant. The reciprocal hybrids (6*4) and (6*2) were superior and gave highest yield per plant, highest fruit weight and highest hybrid vigor. The values of dominance genetic variance were more than the values of additive genetic variance for total yield and yield components, this reflects that the reduction of the values of narrow sense heritability, and on the values of the average degree of dominance which were more than one in all studied traits. While in the reciprocal hybrids the values of additive genetic variance were more than the values of dominance genetic variance in yield and yield components this reflects that the increased of the values of narrow heritability and the reduction of the values of average degree of dominance were less than one.

Key words : Tomato, hybrid vigor, genetic parameters.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetable crops and the cultivated area has increased as a result of increasing demand for food and industrial importance. Local cultivars suffer from a genetic deterioration and a decrease in productivity. Therefore, plant breeders should pay attention to raise and improve the yield and quality of the crop by obtaining hybrids or varieties of high productivity by adopting suitable genetic programs by cultivating genetically pure strains to obtain the first generation hybrids, which are often characterized by the vigor of hybrid or hybrid abundance, which outperforms their productive qualities on the best parents (Hassan, 2005). Estimating genetic variability was one of the most important tools of plant breeders. It is possible to know the type of genetic action that controls the characteristic and thus to know the best breeding method that can be followed to improve crop characteristics (Abdul Rasoul, 2003). Elsahookie (2006) reports that hybrids are faster than their parents in cell divisions and that this status falls under the influence of non additive genes. Many researchers have conducted numerous studies on the hybrid vigor and the estimation of some genetic features in the tomato, including Abdul Rasool (2003), Jubouri *et al.* (2008). The aim of the research is to produce individual hybrids of the first generation in tomato with superior production characteristics compared with their parents and evaluate their performance by estimating some genetic parameters and the vigor of the hybrids.

Materials and Methods

Six locally derived pure lines were used (AbH-P-3, AbH-Y-1, AbK-R-13, Ab-KY-2, AbH-R-9 and 6) - Ab-

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R-7). The seeds of the pure lines mentioned in the plates were planted on 25 of December 2016 and after the full size of the seedlings were transferred on 20 of January 2017 to the non heated plastic house and planted as lines and each line containing 30 plants, the breeds were introduced in the program of full Diallel cross- according to the first method developed by Griffing (1956) model I. The full cross was carried out after the process of emasculation and before the day of flowering after the maturity of the fruits, seed were manually collected to be planted in the second season. The seeds (parents, hybrid and reciprocal hybrids and comparison hybrid) were planted in cork seedling trays on 9 of October 2017. Then, seedlings were transferred after the plastic house was set up and the plants were planted according to the Randomized Complete Block Design (RCBD) with three replicates. The experimental unit consisted of 10 plants with a total of 36 genotypes in one replicate.

The studied traits

Flower set percentage (%), Average number of fruits per plant, average fruit weight (gm), plant yield (gm) and total soluble solids ratio (TSS %).

Results and Discussion

Flower set percentage (%)

The results of table 1 showed significant differences between the genotypes in the ratio of the flower set. Parent 4 gave the highest mean of 56.24%, while the parent 3 gave the lowest average of the flower set rate of 18.99%. The crosses are differed significantly in the mean of this characteristic, the diallel cross 4 * 5 and reciprocal cross 5 * 2 are superior on their parents and on other combinations and on the overall mean rate, giving 75.42% and 71.21% respectively, while the lowest percentage of flower set in diallel cross 3 * 5 and 6 * 3 with 9.46% and 30.62%, respectively. These differences may be due to the nature of the genotype and the extent to the environmental conditions. Table 8 showed that eight diallel cross and ten reciprocal cross have achieved a positive hybrid vigor with percentage of 107.00% and 141.10% fordiallel cross 1 * 3 and reciprocal cross 3 * 1 respectively. Positive values of hybrid vigor indicated that the superior dominance of fathers 'genes toward the higher father, which gave the best mean of the flower set ratio, while the negative values revealed a partial dominance of the fathers' genes towards the lower father, which gave a lower average flower set ratio. The results of table 3 showed that the father 4 gave the highest positive general combining ability (11.059), which indicates a positive public coalition towards the best parents, while father 3 showed the lowest percentage of the effects of general combining ability reached -5.455. The results of the same table showed that there were nine diallel crosses and seven reciprocal crosses that showed positive values for the effect of the specific combining ability. The highest positive and significant value of the special effect in diallel cross 1 * 3 was 16.550, while the highest values positive and significant for special influences in reciprocal cross of 6 * 3 was 16.410in addition, there were some reciprocal and diallel crosses that showed negative values for the effect of specific combining ability. These results are consistent with Agarwal *et al*. (2014) and Shankar *et al*. (2013).

Number of fruit per plant

The results of table 1 indicated that there were significant differences between the genotypes in the fruits number of the plant. Parents 2 and 4 gave the highest average number of fruits per plant 37.29 and 37.03 fruits respectively, while the lowest value was for father 3, which gave 8.98 fruit. The diallel cross and reciprocal cross were also different depending on the different parents in this position. Seven diallel crosses and 10reciprocal crosses the best one is 4 * 5 giving 64.97 fruit followed by 2 * 4, which gave 64.60 fruit while diallel crosses of 3 * 5 gave 6.76 fruit. In contrast, the of reciprocal crosses 6 * 4, 5 * 4, 2 * 1 and 4 * 3 gave significant values of 66.46, 64.11, 61.91 and 61.01 respectively, while the lowest value in of reciprocal crosses 5 * 3 was 20.61 fruit compared to the general mean 38.05. Table 2 showed that the diallel cross and reciprocal cross gave positive and moral values for the hybrid vigor attributed to the highest parents. Moreover, the hybrid 1 * 3 showed the highest hybrid vigor of 236.25% and 11cross showed significant and positive values for increasing the number of fruits per plant. In contrast, reverse bias 3 * 1 gave the highest positive hybrid vigor of 275.72% while reverse 6 * 2 showed a negative hybrid vigor of -33.60%. This may be due to the effect of cytoplasmic inheritance of mother plants in transmitting their traits towards increase the number of fruits, and the positive values of the hybrid vigor refers to the existence of the rule of over dominance genes towards the increase in the number of fruits. The results of Table 3 showed that parents 2 and 4 gave positive and significant values for the effect of general combining ability of 7.126 and 12.997, respectively, while the rest of the six fathers gave negative values. As for the ability of special combining, the same table shows that the cross-manipulation 1 * 2 gave the highest positive significant values of 19.785. As for the specific combining ability for the reciprocal cross 6 × 5 gave the highest

Table 1 : Average of some studied traits of the parents and their hybrid and opposite crosses of the tomato crop.

Genotypes	Flower set percentage	Number of fruit per plant	Fruit weight (gm)	Plant yield (gm)	TSS %
1	25.19	10.94	72.57	794.64	3.83
2	44.25	37.29	57.63	2167.10	3.47
3	18.99	8.98	62.37	561.10	4.40
4	56.24	37.03	49.00	1816.44	4.90
5	37.27	19.75	82.53	1632.57	3.43
6	38.60	16.92	75.13	1281.88	3.27
Diallel hybrids					
1×2	62.50	61.42	89.2	5478.14	4.83
1×3	52.15	36.80	103.8	3799.81	4.80
1×4	29.11	24.76	101.73	2515.48	5.03
1×5	45.34	22.84	82.77	1891.76	5.07
1×6	32.89	23.44	93.83	2237.61	5.60
2×3	26.44	27.82	112.07	3105.82	4.07
2×4	71.16	64.60	70.43	4552.49	5.23
2×5	42.55	43.50	85.77	3728.36	4.20
2×6	52.67	49.44	58.07	2870.81	5.47
3×4	70.39	58.01	52.87	3064.45	3.40
3×5	9.46	6.76	96.17	647.29	3.77
3×6	63.44	26.62	64.67	1720.47	3.47
4×5	75.42	64.97	61.73	14007.10	3.63
4×6	49.46	32.44	86.60	2812.18	3.40
5×6	57.53	50.77	106.47	5332.66	3.33
Reciprocal hybrids					
2×1	54.10	61.91	85.13	5420.02	4.97
3×1	60.74	41.12	96.63	2384.24	5.17
4×1	61.33	40.88	62.81	2568.65	4.63
5×1	52.04	41.40	102.00	4227.86	4.33
6×1	43.61	40.62	57.97	2354.76	3.23
3×2	59.58	31.43	84.90	2665.34	3.80
4×2	44.87	59.72	59.43	3547.84	5.50
5×2	71.21	41.40	90.33	3738.33	3.37
6×2	32.46	24.76	109.00	2715.71	4.27
4×3	65.64	61.01	65.70	4009.47	3.67
5×3	39.25	20.61	62.13	1272.17	3.07
6×3	30.62	23.80	98.93	2350.75	4.80
5×4	67.17	64.11	67.37	4455.33	3.73
6×4	66.82	66.46	80.10	5546.14	4.40
6×5	32.93	20.86	93.74	1955.28	4.83
L.S.D5%	5.066	4.184		7.541	0.218

positive significant values of 14.958.

Average fruit weight (gm)

Table 1 shows that the parent 5 gave the highest average of fruit weight 82.75 g, thus exceeding all parents. The genetic differences between the parents were reflected on the resulting interactions. The diallel cross 2x3 was more than in all genotypes, giving the highest yield of 112.01 g. In contrast, the 2 * 6 was more than the rest of the inversion, giving 109.00 g for the weight of the fruit. The results of table 2 showed that eleven of the samples showed a positive hybrid vigor of 79.69 and45.96 for diallel cross 2 * 3 and for reciprocal

Table 2 : Values of the hybrid vigor for reciprocal and reverse manipulation on the basis of deviation from the best parents.

Diallel hybrids	Flower set percentage	Number of fruit per plant	Fruit weight (gm)	Plant yield (gm)	TSS %
1×2	41.23	64.73	22.92	152.79	26.09
1×3	107.0	236.25	43.04	378.18	9.09
1×4	-48.25	-33.15	40.19	38.48	2.72
1×5	21.66	15.66	0.28	15.88	32.17
1×6	-14.79	38.58	24.89	74.56	46.06
2×3	-40.25	-25.39	79.69	43.32	-7.58
2×4	26.52	73.24	22.21	110.07	6.80
2×5	-3.36	16.67	3.92	72.04	21.15
2×6	19.02	32.59	-22.72	32.47	57.69
3×4	25.15	56.65	-15.23	68.71	-30.61
3×5	-74.61	-65.79	16.53	-60.35	-14.39
3×6	64.36	57.36	-13.93	34.21	-21.21
4×5	34.11	75.44	-25.20	111.40	-25.85
4×6	-12.06	-12.39	15.26	54.82	-30.61
5×6	49.06	157.08	29.00	226.64	-2.91
Reciprocal hybrids					
2×1	22.25	66.05	17.32	150.11	29.57
3×1	141.10	275.72	33.16	200.04	17.42
4×1	9.06	10.40	-13.45	41.41	-5.44
5×1	39.64	109.64	23.59	158.97	13.04
6×1	13.00	140.14	-22.85	83.70	-15.65
3×2	34.63	-15.71	36.13	22.29	-13.64
4×2	-20.21	60.17	3.12	63.71	12.24
5×2	60.92	11.03	9.45	72.50	-2.88
6×2	-26.64	-33.60	45.96	25.32	23.08
4×3	16.72	64.73	5.34	120.73	-25.17
5×3	5.30	4.34	-24.72	-22.08	-30.30
6×3	-20.68	40.67	31.68	83.38	9.09
5×4	19.44	73.11	-18.38	145.28	-23.81
6×4	18.81	79.46	6.61	205.33	-10.20
6×5	-14.69	5.60	13.57	19.77	40.78
S.E	7.93	13.70	4.58	24.95	4.45

cross 6 * 2, while the rest of the other reactions showed negative hybrid vigor relative to the highest parents. The positive values of hybrid vigor indicated the over-dominance of genes that control the rate of fruit weight, which makes hybridization effective in inheriting it. Negative values were the result of the partial dominance of genes in order to reduce the weight of a single fruit. This result is consistent with what Zubai (2004), Jabouri *et al*. (2008) and Singh (2011) found. Table 3 shows that parents 1 and 5 obtained the highest positive and significant value for the effect of the general combining ability to increase the weight of the fruit while the parent 4 showed the lowest value of the effect of the general combining ability, this indicating that the general combining was weak towards increasing fruit weight. Diallel cross 2 * 3 gave the highest positive value of 18.306 for the effects of special combining ability while eight reciprocal hybrids showed positive and significant values for the special combining ability effect of reciprocal crosses. The highest positive value was obtained in the cross 4 * 1 which gave 19.463.

Plant yield (gm)

The results of table 1 showed the superiority of parent 2 with the highest mean of 2167.10 g compared to the lowest mean of the third parent (561.10 g). The diallel

Table 3 : Values of the combining ability effects for special and parents for the reciprocal and inverse manipulation.

Effects	Flower set percentage	Number of fruit per plant	Fruit weight (gm)	Plant yield (gm)	% TSS
g1	-3.078	-3.165	5.021	-328.535	0.379
g2	2.075	7.126	-0.040	312.254	0.154
g3	-5.455	-8.595	0.155	-1022.333	-0.166
g4	11.059	12.997	-12.831	1025.165	0.137
g5	-1.141	-3.195	4.399	509.274	-0.382
g6	-3.460	-5.168	3.296	-495.825	-0.121
Diallel hybrids					
1×2	10.87	19.78	2.123	2264.53	0.14
1×3	16.55	12.79	14.978	1242.06	0.54
1×4	-11.19	-14.93	10.018	-1355.40	0.09
1×5	4.48	0.56	2.900	-321.76	0.47
1×6	-3.64	2.44	-12.480	-80.29	-0.07
2×3	-2.04	-6.83	18.306	394.83	-0.29
2×4	-3.55	4.11	-2.257	-488.09	0.84
2×5	8.92	-9.73	3.628	-1207.32	0.21
2×6	-4.48	-2.78	0.548	-224.00	0.60
3×4	13.98	17.19	-8.103	333.30	-0.67
3×5	-17.48	-12.45	-5.463	-1728.04	-0.27
3×6	7.51	1.05	-1.713	352.93	0.19
4×5	12.95	16.81	-7.081	4495.94	-0.30
4×6	2.11	3.70	12.823	448.98	-0.35
5×6	1.40	6.26	12.344	429.69	0.35
Reciprocal hybrids					
2×1	4.20	-0.25	2.033	29.06	-0.07
3×1	-4.30	-2.16	3.583	707.78	-0.18
4×1	-16.11	-8.06	19.463	-26.59	0.20
5×1	-3.35	-9.28	-9.617	-1168.05	0.37
6×1	-5.36	-8.59	17.933	-58.57	1.18
3×2	-16.57	-1.81	13.583	220.24	0.13
4×2	13.14	2.44	5.500	502.32	-0.13
5×2	-14.33	1.05	-2.283	-4.98	0.42
6×2	10.10	12.34	-25.80	77.55	0.60
4×3	2.37	-1.50	-6.417	-472.51	-0.13
5×3	-14.89	-6.93	17.02	-312.44	0.35
6×3	16.41	1.41	-17.133	-315.14	-0.67
5×4	4.13	0.43	-2.817	4775.89	-0.05
5×6	-8.68	-17.01	3.250	-1366.98	-0.50
6×5	12.30	14.96	6.365	1688.69	-0.75

cross 1 * 2 gave the highest yield of 5478.14 g, while the Diallel hybrid 3 * 5 gave lowest mean of 647.29 g. The reciprocal hybrid 6 * 4 gave the highest average of 5546.14 g Plant, while the lowest average in 5 * 3 was 1272.17 g. This difference in plant yield may be due to the role of cytoplasmic inheritance and its interaction with nuclear genetics as well as the environmental factor in controlling the inheritance of this characteristic. These results are consistent with results of Abdul Rasool (2003).

The hybrid vigor values differed significantly for the plant yield value. The diallel hybrid 1 * 3 showed the highest value of 378.18%, while the reciprocal hybrid 6 * 4 gave the highest hybrid vigor of 205.33%. The difference between parents in reciprocal and diallel may

result in high hybrid abundance and high yield, which consistent with finding of Abdul Rasool (2006) and Khoja *et al*. (2015). Table 3 indicated that parent 2 showed the highest value of general combining ability 312.254 and the effect of the special combining ability was positive in seven reciprocal hybrids ranging from 4495.940 in the l cross 4 * 5 and 333.295 in the cross 3 * 4 , while it is positive in seven reciprocal crosses ranging from 4775.887 to the reverse 5 * 4 and 29.057 for the reverse 2 * 1 and negative in eight reverse crosses ranging from -4.985 in the reverse hybrid 5 * 2 and -1366.980 in the hybrid Reverse 6 * 4.

Total soluble solids (TSS %)

Table 1 shows significant differences between the genotypes. parent 4 was the highest mean of 4.90% compared to parent 6, which gave 3.27%. The difference between the parents resulted in differences between their Diallel and reciprocal crosses. The Diallel hybrid 1*6 gave a higher average of 5.60% compared to Diallel hybrid 5 * 6 which gave the lowest percentage of 3.33%. In contrast, the highest significant value was found in the 4 * 2 contrivance of 5.50% compared to the reciprocal hybrid of 6 * 1 which gave 3.23. The results of Table (2) showed that the Diallel cross 2 * 6that gave a positive value of hybrid vigor of 57.69% while the lowest value was WAV WAV **30.61**% in 3 *6. The highest positive hybrid vigor was 40.87% compared to the reverse 3 * 5, which showed the lowest negative values of 30-30%. (Sahuki, 2006).

Table 3 demonstrated that the parent 1 showed the highest positive value of the general combining effect (0.397) compared to the lowest negative values of the parent5 reached -0.382. The difference between the values was reflected on the diallel and reciprocal crosses. The diallel hybrid **2** WAV **4** gave the highest positive value of the special combining effect of 8.84 and the diallel hybrid 3 * 4 showed the lowest value of SCA of -0.670. In the reciprocal crosses The highest positive value for SCA was 1.183 in the reciprocal hybrid 6*1, while the reciprocal cross6 * 5 gave the lowest negative value of -0.750. This confirms that the hybridization followed by the selection is the appropriate way to improve this trait. This result is consistent with findings of Yadav (2013), Asif *et al*. (2014) and El-Gabry (2014).

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