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PERFORMANCE, HERITABILITY AND CORRELATION COEFFICIENTS FOR SOME IMPORTANT TRAITS IN TOMATO UNDER NORTH SINAI CONDITION

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ABSTRACT

Six diverse lines of tomato were crossed with six testers in line x tester mating fashion to study some plant and fruit characteristics. The experiment was conducted at the Exp. Farm, Fac. of Environ. Agric. Sci., El Arish, Suez Canal Univ., Egypt, during the period from 2012 to 2014. The test of significance and performance revealed that the genotypes, parents and crosses mean squares were highly significant for all studied traits, except number of branches/ plant. The overall mean of F_1's surpassed their parents in all traits, except fruit firmness and total soluble solids percentage (T.S.S.%). The mean of F_1's exceeded the check hybrid in some traits; viz., plant height, number of branches per plant, total number of fruits/plant, yield/plant and total soluble solids percentage (T.S.S.%). In the remaining traits the overall mean of F_1's was lower than that of parents and the check hybrid. However, this did not imply the absence of superior hybrids than mid-parents or the check hybrid. Heritability estimates in broad sense were high for all traits, except it was low for total yield/plant, Heritability in narrow sense was low for all studied traits. The percentage of G.C.V/P.C.V. was high for all studied characters, except it was moderate for total yield/plant. Significant or highly significant positive correlations were found between: Plant height with number of branches per plant and vitamin C content. Also, total number of fruits/plant with yield/plant. yield/plant with average fruit weight and Fruit firmness. Significant or highly significant negative correlations were found between: total number of fruits/plant with average fruit weight and fruit firmness.

keywords: Performance, heritability, correlation coefficients, tomato hybrid, T.S.S.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most economically important vegetable crops grown in Egypt, for fresh consumption and processing.

With the cumulative increase in this crop, there is a need for development of hybrids and varieties with high yield, quality and tolerant to environment stresses. Heritability in both broad and narrow sense is very important and should be recognized as a first

step before starting any breeding program. Heritability in broad sense includes all types of genetic variances, consequently plant breeder's count on the narrow sense heritability which estimates the portion of genetic variance due to additive gene action. Heritability in broad sense was detected by **Abd El-Rahim (1989)** for plant height, number of branches per plant, **Metwally *et al.* (1990)** for plant height, number of branches per plant, total fruit yield/plant, ascorbic acid content; **Wessel-Beaver and Scott (1992)** for fruit firmness; **Zanata (1994) and Abdel-Ati *et al.* (2000)** for fruit firmness ;**Amin *et al.* (2001)** for weight/plant and number of fruits/plant; **Bogoljub (2010)** for yield/plant, Masry (2014) for plant height, number of branches, fruit yield/plant and ascorbic acid content; Sivaprasad (2008) for average fruit weight; **Hegazi *et al.* (1995) and Salib (1999)** for TSS, plant height and number of branches per plant. Heritability in narrow sense was detected by **Metwally *et al.* (1990)** for plant height, number of branches per plant, total fruit yield/plant, ascorbic acid content; Masry (2014) for plant height, number of branches, yield/plant and total soluble solids (TSS).

Knowledge of degree and direction of correlation among different traits of tomato plants are great important. Phenotypic and genotypic correlation coefficients provide a measure for this type of correlation between traits that may be used as useful indicator for indirect selection programs. So many studies on tomato showed, high positive direct effect among them, **Zanata (1994)** for Plant height with each of number of fruits, yield/plant, average fruit weight and fruit diameter; **Mohanty (2002)** for number of branches per plant with average fruit weight and yield; **Joshi *et al.* (2004) and Mehta and Asati (2008)** for plant height with fruit yield; **Masry (2014**) for number of branches, number of fruits/plant, total yield/plant, average fruit weight, fruit diameter and total soluble solids (TSS%).

On the other hand many studies showed negative effect among them**,** **Zanata (1994)** for Plant height with number of branches/plant, and negative correlation was found between number of fruits per plant with average fruit weight **(Youssef, 1997 and Salib, 1999).**

MATERIALS AND METHODS

The experiment work was carried out at the Experimental Farm, Faculty of Environmental Agricultural Sciences, El Arish, Suez Canal University, Egypt, during the period from 2012 to 2014.

The genetic materials used in this study were six heat tolerant lines introduced from Asian Vegetable Research and Development Center (AVRDC); viz., CLN3125L, CLN1621F, CLN 3070J, CLN2413D, CLN5915-206D4 and CLN3078A used as female parents. Six cultivars of tomato were used as testers; viz., Castle Rock, Peto 86, FM–9, Super Strain-B, Super Marmand and Rio Grande.

The common hybrid in El-Arish region "Alisa F_1" was used as a check hybrid.

In the first season of 2012, crossing was made among parental genotypes using six lines as female, while the six *cvs*. were used as testers to produce 36 F_1. In the second season of 2013, the resulted 36 F_1 were planted to produce 36 F_2 seeds and crosses among parents were done to produce enough F_1 seeds again. In the third season of 2014, all genotypes (six lines, six testers, 36 F_1, 36 F_2 and check hybrid Alisa F_1) were evaluated under the open field conditions. Seedlings were transplanted on April 1st.

A randomized complete block design with three replicates was used in season of 2014, each replicate contained 85 genotypes, the plot area was 12 m^2. Drip irrigation system was used, dripper lines were spaced 1.2 m between each, plants spaced 50 cm in the same row.

Other agricultural practices for tomato production were done as recommended in the open field in North Sinai region.

DATA RECORDED

Data were recorded for plant height (cm) and number of branches/plant after four months from transplanting on 5 plants chosen randomly from each plot. Total yield/plant (kg) and total fruit number /plant were calculated from all harvested fruits. Average fruit weight (g) was calculated by dividing total weight of all harvests over total number of fruits. From each plot five fruits were taken randomly from the third harvest to determine total soluble solids percentage (TSS %) by a hand refractrometer; ascorbic acid content (mg /100g fruit fresh weight) was determined according to the methods of **A.O.A.C. (1990)** and fruit firmness (kg/cm^2) was measured by using a needle type of pocket penetrometer.

Data were calculated and statistically analyzed as out lined by **Cochran and Cox (1957).** Heritabilities in broad and narrow sense were obtained as described by **Burton and Devan (1953),** Phenotypic (rph) and genotypic (rg) correlations among pairs of studied traits were made as outlined by Steel and **Torrie (1980).**

Result and Discussion

- Performance of Parents and their F_1 and F_2 Hybrids

Plant height (cm)

Data presented in Table (1) show that two lines (CLN3078A and CLN2413D) had the tallest plants (76.0, and 73.33 cm), while the shortest line was CLN3125L (49.33 cm). As regard to tester cultivars, no cultivars had significant value with Plant height

Two F_1 crosses (6x11 and 1x11) had the tallest plants from F_1 genotypes (110.00 and 103.75 cm respectively). While the shortest crosses were ranged from 2x10 to 2x12 with value 46.58 to 53.00 cm, respectively.

Out of 36 F_2 crosses, only three crosses (5x12, 6x9 and 1x10) had highest significant values for plant height (77.00, 76.08 and 75.08 cm). While the lowest were ranged from 48.75 for 2x10 to 55.92 for 5x9.Generally, average of F_1 crosses was higher than their parents, F_2 populations and check hybrid (Alisa F_1). In this concern, many studies indicated that F_1 plants exceeded their parents in growth rate and plant height, indicating hybrid vigor **(Zanata, 1994; Salib, 1999; Asati *et al.* 2007; Shende *et al.* 2012).**

Number of branches/ plant

Data presented in Table (1) show that the five lines CLN3078A, CLN2413D, CLN5915-206D4, CLN1621F and CLN3125L) had the highest number of branches per plant and significant with values of (6.33, 6.22, 6.00, 5.61 and 4.94) respectively.

While, the lowest number (4.89) was observed with the line CLN 3070J. As for tester cultivars, five cultivar (Super Marmand, Rio Grande, Castle Rock, Peto 86 and FM – 9) recorded the highest number of branches and differed significantly than Super Strain B which recorded the lowest value (4.06).From 36 F_1, 12 crosses (6x11, 5x11, 4x12, 5x12, 1x11,2x8, 6x12, 5x9, 2x11, 3x11, 4x9, 6x7 and 6x9) had the highest values for number of branches/plant and non-significant between them with values (8.17, 7.89, 7.83, 7.78, 7.67, 7.56, 7.22, 7.17, 7.06, 7.06 6.83, 6.89 and 6.78 respectively). For F_2 populations, six crosses (5x12, 1x7, 6x9, 4x11, 1x9) and 6x12) had the highest number of branches per plant with values of 8.33, 8.17, 7.67, 7.28, 7.00 and 7.00, respectively. On the other hand the lowest values ranged from 3.17 for 3x12 to 4.39 for 3x11 with non-significant between them.

Table (1): Means performances of some evaluated vegetative traits and yield of tomato plants in 36 F1's, 36 F_2's, their respective parents and check hybrid.

Characters / Genotypes	plant height (cm)	number of branch plant	total yield/plant	
			Number	yield (Kg)
Lines (♀)				
1-CLN3125L	49.33	4.94	45.92	1.29
2-CLN1621F	58.75	5.61	41.95	1.42
3-CLN 3070J	57.67	4.89	83.04	1.54
4-CLN2413D	73.33	6.22	32.69	1.02
5-CLN5915-206D4	67.25	6.00	47.97	1.46
6-CLN3078A	76.00	6.33	50.72	1.78
Testers (♂)				
7- CastleRock	49.25	5.11	35.05	1.21
8- Peto 86	46.50	4.83	54.62	1.66
9- F M – 9	44.83	4.44	35.78	1.88
10- Super Strain B	48.75	4.06	33.74	1.27
11-Super Marmand	51.08	6.56	23.83	1.09
12- Rio Grande	51.67	5.44	38.67	1.00
Average	56.20	5.37	43.67	1.39
F_1's				
1x7	57.17	5.56	31.19	1.25
1x8	58.08	5.28	69.58	1.88
1x9	60.67	4.39	55.10	2.09
1x10	49.58	5.33	39.61	1.41
1x11	103.75	7.67	51.56	1.43
1x12	66.50	6.17	89.61	2.04
2x7	54.83	7.00	62.67	2.11
2x8	55.83	7.56	76.17	1.80
2x9	51.25	4.50	63.37	1.98
2x10	46.58	5.06	52.25	1.03
2x11	68.83	7.06	65.75	1.78
2x12	53.00	6.72	72.44	1.50
3x7	60.33	5.72	53.69	2.20
3x8	70.58	6.28	63.51	2.28
3x9	69.67	5.78	52.26	2.20
3x10	63.67	5.61	47.53	1.81
3x11	84.25	7.06	61.65	1.90
3x12	60.92	5.56	63.16	2.00
4x7	73.50	6.50	54.17	2.20
4x8	84.25	6.33	44.78	1.71
4x9	81.87	6.89	49.63	2.07
4x10	70.67	6.22	46.38	2.00
4x11	68.42	5.78	50.89	2.20
4x12	71.83	7.83	38.05	1.84
5x7	66.77	6.61	56.36	2.07
5x8	88.17	5.67	48.14	1.32
5x9	81.17	7.17	50.75	1.86
5x10	72.92	5.00	36.37	1.79
5x11	71.96	7.89	70.95	2.10
5x12	78.75	7.78	52.42	1.88

Table (1): cont.

Characters / Genotypes	plant height (cm)	number of branch plant	total yield/plant	
			Number	Yield (Kg)
6x7	86.75	6.83	39.57	1.79
6x8	52.68	4.67	75.48	2.20
6x9	65.50	6.78	57.10	2.30
6x10	62.00	6.00	47.27	2.19
6x11	110.00	8.17	70.06	2.02
6x12	82.50	7.22	48.51	1.92
Average	69.59	6.32	101.05	1012.12
Check hybrid				
Alisa	53.67	4.83	45.06	1.80
F_2's				
1x7	68.92	8.17	56.72	2.00
1x8	59.17	6.83	36.10	1.44
1x9	61.83	7.00	45.37	2.04
1x10	75.08	5.00	56.04	2.00
1x11	61.44	5.72	56.49	1.73
1x12	56.07	5.00	56.75	1.85
2x7	56.17	4.61	84.31	2.07
2x8	61.92	5.94	65.64	1.86
2x9	49.75	4.17	73.74	2.00
2x10	48.75	5.17	71.19	1.95
2x11	51.25	6.50	69.08	1.94
2x12	57.50	6.33	80.70	1.76
3x7	53.42	5.56	46.32	2.06
3x8	58.17	5.06	53.16	2.17
3x9	53.42	5.61	40.06	2.13
3x10	58.75	4.28	46.35	1.93
3x11	50.08	4.39	44.67	2.08
3x12	50.00	3.17	40.05	2.04
4x7	66.50	5.17	44.23	2.18
4x8	63.25	4.00	52.41	1.98
4x9	58.58	5.72	42.02	2.05
4x10	57.67	4.61	57.65	1.97
4x11	61.58	7.28	36.60	1.77
4x12	55.50	6.17	60.33	2.05
5x7	53.17	4.17	39.69	1.87
5x8	57.92	5.94	30.29	1.16
5x9	55.92	6.00	45.04	2.00
5x10	52.50	5.72	38.40	1.71
5x11	50.92	6.39	60.16	1.97
5x12	77.00	8.33	42.90	1.67
6x7	57.50	6.50	40.28	1.72
6x8	61.00	5.00	54.14	1.96
6x9	76.08	7.67	67.43	2.03
6x10	64.08	5.50	62.25	2.13
6x11	54.08	6.33	53.90	2.07
6x12	61.67	7.00	44.10	2.07
Average	58.795	5.723	52.63	1.93
LSD at .05	7.297	1.409	10.110	0.281
LSD at .01	9.662	1.865	13.387	0.372

Generally, mean of F_1 plants had higher number of branches per plant than F_2 populations, parents and check hybrid (Alisa F_1). Many investigators among them El-Sayed 1997), **Youssef (1997) and Asati *et al.* (2007)** reported that F_1 hybrids were more vigours in vegetative traits than both of their parents and the F_2 populations.

Total Number of fruits/plant

Data in Table (1) revealed that line CLN 3070J (83.04) had the highest significant total number of fruits / plant. On the other hand CLN2413D (32.69) and CLN1621F (41.95) had the lowest.

Concerning testers, Peto 86 produced the highest total number of fruits (54.62), while the lowest ones was Super Marmand (23.83) and Super Strain B (33.74).

Only one cross (1x12) had highest significant total number of fruits (89.61), while the lowest one ranged from (31.19 for 1x7 to 39.57 for 6x7). Out of 36 F_2 population (2x7 and 2x12) had the highest total number of fruits (84.31 and 80.70), and the lowest ones ranged from 5x8 (30.29) and 6x7 (40.28).

Generally, mean of F_1 plants had higher total number of fruits/ plant than F_2 populations, check hybrid (Alisa F_1) and parents, indicating the levels for this trait Many investigators among them **Abd-Allah (1995) and Rattan (2007)** found that each of heterosis over the mid-parents, better parent and check hybrid was positive and significant in most crosses of tomato.

Total Yield/plant

Data in Table (1) show that 2 lines CLN3078A and CLN 3070J produced the highest yield/plant (1.78 and 1.54 kg).

The tester, FM–9 and Peto 86 had the best (1.88 and 1.66 kg). Therefore, the F_1 crosses ;i.e., 6x9, 3x8, 3x7, 3x9, 4x7, 4x11, 6x8, 6x10, 5x11, 1x9, 5x7 and 1x12 produced the highest significant for yield/ plant with non-significant differences between them (2.30, 2.28, 2.20, 2.20, 2.20, 2.20, 2.20, 2.19, 2.10, 2.09, 2.07 and 2.04 kg/plant) respectively.

In F_2 populations, 25 once had the highest values which ranged from 2.18 kg/plant for 4x7 to 1.93 kg/plant for 3x10 had the highest value.

Generally, mean of F_2 plants (1.93 Kg) had higher yield/plant than F_1 populations (1.89 Kg), check hybrid (1.80 Kg) and parents (1.39 Kg). Similar results were found by **Uppal *et al*. (1997) and Sharma (2003).**

Average fruit weight

Data presented in Table (2) show that lines, CLN3078A, CLN1621F, CLN2413D, CLN5915-206D4 and CLN3125L manifested the heaviest average fruit weight with non-significant between them (35.21, 33.66, 31.26, 30.60 and 28.11g, respectively).On the other hand the lowest one was CLN 3070J (18.54 g).

As for testers, two cultivars (FM–9 and Super Marmand) recorded the heaviest significant average of fruit weight (52.54 and 45.73 g). While, Rio Grande and Peto 86 had the lowest ones (26.02 and 30.84 g).

Regarding the crosses, each of 5x10, 4x12, 6x10, 4x10, 4x11and 3x9 exhibited high values with non-significant among them for average fruit weight (49.38, 48.44, 46.38, 43.40, 43.23 and 42.40 g, respectively). While the lowest ones ranged from (19.87 g for 2x10 to 27.15 g for 1x8).

In F_2 populations, crosses 3x9, 3x12, 4x7, 4x9 and 4x11 recorded the highest significant with values 54.73, 50.88, 49.63, 49.38 and 48.71, respectively, on the other hand the lowest ones ranged from 21.89g for 2x12 to 28.94 g for 2x8.

Generally, mean of check hybrid had the heaviest fruit than F_2 populations, F_1 plants and parents. Similar results were found on tomato by Rattan (2007) who could not record any hybrid better than the standard check.

Fruit firmness (Kg/cm^2)

Data in Table (2) clear that three lines (CLN2413D, CLN1621F and CLN3125L) recorded the highest significant fruit firmness (2.35, 2.15 and 2.08 Kg/cm^2).

With respect to testers, data show that the highest fruit firmness was recorded with parent Super Strain B (2.92 Kg/cm^2).

From 36 F_1, tow crosses (6x10 and 2x12) had the high fruit firmness and significant with values (2.67and 2.40 Kg/cm^2). While in F_2 crosses (3x10 and 6x10) had the highest significant fruit firmness.

Generally, mean of check hybrid (Alisa F_1) had higher fruit firmness than parents, F_2 populations and F_1 plants.

Total soluble solids percentage (TSS %)

Data listed in Table (2) show that, the lines CLN1621F, CLN5915-206D4 and CLN 3070J recorded the highest significant TSS % (8.17, 8.17 and 7.50%, respectively). While, the lowest ones were CLN3125L, CLN2413D and CLN3078A with value 6.83, 6.83 and 7.17% respectively. Moreover, Peto 86, Super Marmand as a testers cultivar had the highest significant value.

Two crosses in F_1 (2x11 and 4x8) had the highest significant value with TSS% (8.50 and 7.83%). Out of 36 F_2 population nine ones 6x12, 2x10, 5x8, 5x9, 6x8, 1x8, 2x7, 3x9 and 6x11) had the highest TSS% (7.83, 7.67, 7.67, 7.33, 7.33, 7.17, 7.17, 7.17 and 7.17%, respectively). Generally, mean of parents were recorded the higher TSS% than each of check hybrid (Alisa F_1), F_1 plants and F_2 populations

Vitamin C content

Data presented in Table (2) revealed that lines CLN5915-206D4 and CLN 3070J had the highest significant value of V.C content compared to other lines. On the other hand the lowest ones were CLN3125L, CLN1621F and CLN3078A with values 16.00, 16.00 and 21.33 mg/100g fresh weight, respectively.

Table (2): Means performances of some evaluated fruit characteristics traits of tomato plants in 36 F_1's, 36 F_2's, their respective parents and check hybrid.

Characters / Genotypes	Average fruit weight (g)	Fruit firmness (Kg/cm^2)	TSS %	Vitamin c (mg/100g fresh weight)
Lines (♀)				
1-CLN3125L	28.11	2.08	6.83	16.00
2-CLN1621F	33.66	2.15	8.17	16.00
3-CLN 3070J	18.54	1.55	7.50	29.33
4-CLN2413D	31.26	2.35	6.83	24.00
5-CLN5915-206D4	30.60	1.83	8.17	34.67
6-CLN3078A	35.21	1.60	7.17	21.33
Testers (♂)				
7- CastleRock	34.31	2.22	6.50	20.00
8- Peto 86	30.84	1.52	7.83	14.67

9- F M – 9	52.54	2.27	5.50	13.33
10- Super Strain B	37.50	2.92	6.05	14.67
11-Super Marmand	45.73	1.38	7.17	13.33
12- Rio Grande	26.02	2.15	6.50	13.33
Average	33.69	2.00	7.02	19.22
F_1's				
1x7	39.99	2.12	7.17	28.00
1x8	27.15	2.37	7.50	50.67
1x9	38.69	2.23	6.33	30.67
1x10	36.39	2.07	6.33	42.67
1x11	28.05	2.03	7.00	48.00
1x12	22.74	2.20	6.50	45.33
2x7	34.05	2.12	6.83	30.67
2x8	23.62	1.80	6.67	30.67
2x9	31.06	1.85	7.67	36.00
2x10	19.87	1.70	6.67	22.67
2x11	26.81	1.63	8.50	38.67
2x12	20.75	2.40	5.83	30.67
3x7	41.05	2.20	6.83	33.33
3x8	36.17	1.97	6.83	41.33
3x9	42.40	2.07	6.00	29.33
3x10	37.74	1.94	6.67	33.33
3x11	30.82	2.02	7.00	28.00
3x12	32.34	1.77	7.17	29.33
4x7	40.92	1.87	7.00	36.00
4x8	38.37	2.10	7.83	29.33
4x9	41.74	1.60	7.67	30.67
4x10	43.40	1.92	7.17	34.67
4x11	43.23	1.48	7.00	36.00
4x12	48.44	1.98	7.17	41.33
5x7	37.02	2.13	7.17	38.67
5x8	27.45	1.88	7.50	33.33
5x9	35.94	1.53	6.33	29.33
5x10	49.38	1.62	6.33	32.00
5x11	29.95	1.52	7.00	20.00
5x12	36.64	1.30	6.50	33.33

Table 9: Con.

Characters / Genotypes	Average fruit weight (g)	Fruit firmness (Kg/cm^2)	TSS %	Vitamin C mg/100g
6x7	42.00	2.25	7.17	30.67
6x8	29.28	2.22	7.67	30.67
6x9	40.89	2.18	7.67	24.00
6x10	46.38	2.67	6.83	26.67
6x11	29.23	2.03	6.67	32.00
6x12	39.52	1.85	6.67	16.00
Average	35.26	1.96	6.97	32.89
Check hybrid				
Alisa	40.00	2.55	6.83	38.67
F_2's				
1x7	35.64	2.27	6.33	24.00
1x8	39.61	2.15	7.17	17.33
1x9	45.38	1.92	5.83	18.67
1x10	36.85	2.18	6.67	17.33
1x11	31.03	1.90	7.00	22.67
1x12	32.63	2.38	6.67	25.33
2x7	24.64	1.87	7.17	28.00
2x8	28.94	1.75	6.50	22.67
2x9	27.27	1.67	6.50	37.33
2x10	27.34	1.97	7.67	16.00
2x11	27.99	1.78	6.50	20.00
2x12	21.89	1.92	6.00	25.33
3x7	45.24	2.35	6.83	20.00
3x8	41.15	2.22	6.67	20.00
3x9	54.73	2.42	7.17	16.00
3x10	41.71	2.92	6.50	22.67
3x11	46.92	2.18	6.00	22.67
3x12	50.88	2.13	7.00	26.67
4x7	49.63	1.52	7.00	36.00
4x8	38.10	2.03	7.00	36.00
4x9	49.38	1.95	6.50	25.33

4x10		34.53	2.13	6.67	37.33
4x11		48.71	1.55	6.67	33.33
4x12		34.74	1.98	6.67	22.67
5x7		47.34	1.80	7.00	22.67
5x8		38.22	1.43	7.67	16.00
5x9		44.42	2.12	7.33	22.67
5x10		44.59	1.52	6.67	22.67
5x11		32.68	1.52	6.83	20.00
5x12		38.86	1.48	6.50	28.00
6x7		42.54	1.98	6.83	18.67
6x8		36.29	2.35	7.33	29.33
6x9		30.65	1.85	6.00	38.67
6x10		34.88	2.67	6.42	25.33
6x11		38.77	2.18	7.17	30.67
6x12		46.93	1.93	7.83	28.00
Average		38.64	1.99	6.79	24.89
LSD	at .05	7.294	0.344	0.759	6.332
	at .01	9.659	0.455	1.005	8.385

As for testers, CastleRock, Peto 86 and Super Strain B recorded the highest values (20.00, 14.67 and 14.67 mg/100g fresh weight) of V.C content. While the lowest ones were FM – 9, Super Marmand, and Rio Grande with the same value (13.33 mg/100g fresh weight). The performance of 36 F_1 hybrids revealed that three crosses (1x8, 1x11 and 1x12,) gave the highest significant values for V.C content (50.67, 48.00 and 45.33 mg/100g F.W, respectively). While, the lowest ones was 6x12 (16.00 mg/100g F.W) and 5x11 (20.00 mg/100g F.W).

In F_2 populations, crosses 6x9, 2x9, 4x10, 4x7, 4x8 and 4x11 recorded the highest value of V.C content with values of 38.67, 37.33, 37.33, 36.00, 36.00 and 33.33 mg/100g F.W, respectively. While the lowest F_2 population, crosses ranged from 20.00 for 2x11 to 16.00 for 2x10 had the lowest ones.

Generally, check hybrid (Alisa F_1) had higher value of V.C content than each of F_1 plants, F_2 populations and parents

- Heritability

Data presented in Table (3) show that heritability estimates in broad sense were high for plant height, number of branches per plant, number of fruits/plant, average fruit weight, fruit firmness, total soluble solids percentage and vitamin C content with values of 94.05%, 77.02%, 80.60%,

Table (3): Estimates of mean performance (x), phenotypic (σ^2ph) and genotypic (σ^2g) variances, phenotypic (P.C.V.%) and genotypic (G.C.V.%) coefficient of variation, broad ($h^2_{b.s.}$) and narrow ($h^2_{n.s.}$) sense heritability for some vegetative traits in parents and F_1 generation after 6x6 factorial crosses of tomato plants.

Characters	plant height (cm)	number of branch / plant	Total yield / plant		Average fruit weight	fruit firminsess	Total soluble solids (%)	Vitamin C content (mg/100g fresh weight)
			No. of fruits/ plant	yield (kg)				
X	66.24	6.08	52.75	1.77	34.93	1.97	7.00	29.47
σ2ph	142.30	0.84	122.25	0.08	29.59	0.06	0.38	43.65
σ2g	133.84	0.64	110.62	0.04	24.14	0.04	0.32	37.87
P.C.V.%	18.01	15.04	20.96	15.81	15.57	11.91	8.76	22.42
G.C.V.%	17.46	13.20	19.94	11.04	14.06	10.62	8.11	20.88
G.C.V. / P.C.V.%	96.0	87.0	95.0	69.0	90.33	89.14	92.60	93.15
h^2b.s.	94.05	77.02	90.49	48.71	0.81	0.79	0.85	0.86
h^2n.s.	6.24	4.19	4.06	2.74	13.91	7.02	-0.03	2.74

81.59%, 79.46%, 85.74% and 86.77 % respectively.Heritability estimates in narrow sense was low for plant height, number of branches per plant and number of fruits/plant, with values of 6.24%, 4.19% and 4.56% respectively. The high heritability in broad sense and low heritability in narrow sense indicate that a major part of total phenotypic variances are due to dominance and / or over-dominance and the environmental influences affected these traits. **(Abd El-Rahim, 1989; Metwally, *et al.* 1990; Zanata, 1994; Metwally *et al.* 1996 and Masry, 2014).**

Regarding the phenotypic and genotypic variances (σ^2ph and σ^2g), the values were 142.30 vs. 133.84 for plant height; 0.84 vs 0.64 for number of branches per plant; 24.57 vs. 19.80 for number of fruits/plant, 29.59 vs. 24.14 for average fruit weight, 0.06 vs. 0.04 for fruit firmness, 0.38 vs 0.32 for total soluble solids percentage, 43.65 vs 37.87 for vitamin c content.

In this respect, all the studied traits showed narrow difference between phenotypic and genotypic variances, which leaded to a close correspondence varies between phenotypic and genotypic coefficient of variations (P.C.V. and G.C.V. %). The estimated P.C.V. vs G.C.V. % was: 18.01 vs 17.46 for plant height; 15.04 vs 13.20 for number of branches per plant; 47.14 vs 42.32 for number of fruits/plant; 15.57 vs 14.06 for average fruit weight; 11.91 vs 10.62 for fruit firmness; 8.76 vs 8.11 for total soluble solids percentage; 22.42 vs 20.88 for vitamin c content.

These results were in agreement with those obtained by **Prashanth *et al.* (2006), Kumar *et al.* (2006), Prashanth *et al.* (2007), Mehta and Asati (2008),** Revanasiddappa **(2008), Sivaprasad (2008) and Masry (2014).**Phenotypic (P.C.V.) and genotypic (G.C.V.) coefficient of variability as well as G.C.V. /P.C.V. percentage were listed in Table (3).

Table (4): Phenotypic (rph) and genotypic (rg) correlation coefficients among 8 characters of tomato plants.

characters	r	1	2	3	4	5	6	7	8
1. Plant height	rph	1	0.591**	0.049	0.078	-0.031	-0.16	-0.160	0.225*
	rg	1	0.587**	0.048	0.086	-0.022	-0.16	-0.166	0.223*
2. Number of branches/plant	rph		1	0.079	0.044	-0.062	-0.31**	-0.313**	0.059
	rg		1	0.083	0.075	-0.036	-0.33**	-0.330**	0.039
3. Total Number of fruits/plant	rph			1	0.431**	-0.477**	-0.06	-0.062	-0.036
	rg			1	0.433**	-0.468**	-0.06	-0.067	-0.035
4. yield/plant	rph				1	0.549**	0.11	0.111	-0.176
	rg				1	0.557**	0.08	0.089	-0.191
5. Average fruit weight	rph					1	0.17	0.177	-0.144
	rg					1	0.16	0.161	-0.160
6. Fruit firmness	rph						1	0.126	-0.155
	rg						1	0.125	-0.150
7. (TSS %)	rph							1	-0.288**
	rg							1	-0.270*
8. Vitamin C content	rph								1
	rg								1

Data in this table show that, G.C.V./ P.C.V. percentage was high for all vegetative traits. Such values of G.C.V./ P.C.V. percentage ranged from 69.0 to 96.0 % for yield /plant and plant height. These results indicate that about 69.0 to 96.0 % of the phenotypic variances were due to genetic ones. Therefore, these traits might be more genotypically predominant and it would be possible to achieve further improvement.

- Phenotypic and genotypic correlation coefficients.

Out of 28 correlations among the studied traits in Table (4 and 5) ^ ones exhibited significant or highly significant correlation coefficients, while the remaining correlation coefficients were low in magnitude and of no predictive value. Plant height had significant or highly significant positive correlation with number of branches per plant and vitamin C content. In these connections **Zanata (1994**) found the same result. Number of branches per plant hade high significant negative correlation with TSS % and fruit firmness.

High significant positive correlation was observed between total number of fruits/plant with yield/plant and negative correlation with average fruit weight. In these connections **Megahed (2002)** found that total number of fruits/plant was significant or highly significant and positively correlated with both total fruit yield and average fruit weight. Total yield/Plant had significant or Highly significant positive correlation with Average fruit weight. On the other hand, significant negative correlation was found between (TSS %) and vitamin c content.

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الملخص العربى

اختبار المعنوية و درجة التوريث و معامل الارتباط علي بعض الصفات الهامة في الطماطم تحت مناخ شمال سيناء

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أجريت هذه الدراسة بمزرعة كليه العلوم الزراعية البيئية بالعريش- جامعه قناة السويس- مصر، خلال الفترة من ٢٠١٢ حتى ٢٠١٤. استخدم في الدراسة سته سلالات من الطماطم وسته كشافات وتم التهجين بينها بنظام السلالة x الكشاف، بهدف دراسة درجة التوريث علي النطاق الضيق والواسع، وتقدير معامل الارتباط لبعض صفات النبات والثمرة في الطماطم. وكانت أهم النتائج المتحصل عليها ما يلي:

كانت الاختلافات بين التراكيب الوراثية، والآباء، والهجن عالية المعنوية لجميع الصفات تحت الدراسة في موسمي الزراعة، وكذلك التحليل التجميعي عدا الآباء بالنسبة لصفة عدد الأفرع للنبات حيث كانت غير معنوية.

تفوق المتوسط العام للهجن علي المتوسط العام للآباء في كل الصفات تحت الدراسة عدا صلابة الثمار، والمواد الصلبة الذائبة الكلية. أيضا تفوق المتوسط العام للهجن علي المتوسط العام للهجين التجاري في بعض الصفات مثل ارتفاع النبات، وعدد الأفرع في النبات، وعدد الثمار الكلي والمحصول الكلي، والمواد الصلبة الذائبة الكلية. أما باقي الصفات تحت الدراسة فكان المتوسط العام للهجن أقل من متوسط الآباء والهجين التجاري، ولكن ذلك لم يمنع من تفوق بعض الهجن علي الهجين التجاري أو متوسط الآباء في كل الصفات المدروسة.

كانت درجة التوريث بمعناها العام مرتفعة لكل الصفات بينما كانت منخفضة لصفات وزن المحصول الكلي. أظهرت النتائج أن درجة التوريث بمعناها الضيق كانت منخفضة لكل الصفات المدروسة. كان نسبة التباين الوراثي إلي التباين البيئي كبيرة بالنسبة لكل الصفات بينما كانت منخفضة لصفة وزن المحصول الكلي.

بالنسبة لمعامل الارتباط من بين ٢٨ ارتباط ناتجة من الارتباط بين ٨ صفة كان هناك ٨٨ ارتباطاً معنوياً أو عالي المعنوية. تشير النتائج إلى وجود ارتباطات موجبة معنوية أو عالية المعنوية بين ارتفاع النبات مع عدد الأفرع علي النبات ومحتوي الثمار من فيتامين ج. كذلك وجد ارتباط موجب بين عدد الثمار الكلي للنبات مع المحصول الكلي. وأيضا ارتباط موجب بين المحصول الكلي مع متوسط وزن الثمرة. وفي الجانب الأخر وجدت ارتباطات سالبة معنوية أو عالية المعنوية بين عدد الأفرع علي النبات وكل من صلابة الثمار ونسبة المواد الصلبة الذائبة الكلية. كما وجد كذلك ارتباط سالب بين عدد الثمار الكلي للنبات مع متوسط وزن الثمرة. كذلك وجد ارتباط سالب بين نسبة المواد الصلبة الذائبة الكلية مع محتوي الثمار من فيتامين ج.

الكلمات الإسترشادية: المعنوية، درجة التوريث، معامل الارتباط، محصول الطماطم، المواد الصلبة الذائبة الكلية.

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