New Processing Tomato Hybrids and Their Stability in Newly Reclaimed Soils in Northern Egypt

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ABSTRACT

Twenty five processing tomato (*Lycopersicon esculentum*) genotypes including; 5 parents, 10 F_1's and 10 F_2 generations were grown in eight environments; consisting of 2 locations (Abbies & Banger El-Sokaer) and 4 seasons (summer and winter of two successive years) to estimate phenotypic stability of fruit weight, number of fruits, early and total yields. The model of Eberhart and Russel was applied in which the stability parameters b and S^2_d that were calculated for each genotype across the eight environments. In addition, the overall mean of each genotype and r^2 were considered. A stable genotype excelled for a particular trait when grown in either favorable or unfavorable environments. A stable genotype for a given trait was defined as one with an individual mean greater than the grand mean $\bar{x} > \bar{X}$, a regression coefficient $(b_1) \leq 1$ (individual genotypic mean regressed against environmental means), a nonsignificant deviation mean squares from regression (S^2_d), a coefficient of linear determination (r^2) > 0.50. The F1 hybrid $P_2 \times P_4$ gave the highest mean total yield (3.14 kg/plant) and it was stable for all studied characters under different environmental conditions. This hybrid when selfed gave an F_2 (first segregation generation) that gave the highest magnitude among the rest F_2's) in total yield (2.56 kg/plant). The F_1 hybrid $P_1 \times P_3$ was stable for total yield, fruits per plant and early yield, while, the F_1 hybrid $P_3 \times P_4$ was stable for total yield, fruits per plant and fruit weight. Heritability percentage was 85.88%, 90.13%, 93.49%and 97.23% for total yield, fruits/plant, early yield and fruit weight, respectively. The results, generally, indicated that tomato genotypes could be differentiated for phenotypic stability of yield and its components or for adaptability to diverse environments. Therefore, through stability analysis, tomato plant breeders can identify hybrids or select advanced breeding lines (parents) that express adaptability for number, weight and yield of fruits to diverse environmental conditions.

INTRODUCTION

Tomato (*Lycopersicon esculentum*, Mill) is one of the most important and popular vegetable crops grown in Egypt. Recently, hybrid tomato cultivars were extensively used in commercial production to increase quantity and quality of fruit yield, though the F_1 hybrid seeds are much more expensive than the seeds of open-pollinated cultivars. Tomato breeders usually focus on increasing fruit yield and quality of the new introduced hybrids. Later, the stability of the fruit yield across divergent environments attracted the attention of plant breeders.

Yield stability has a critical consideration in cultivar development. Crop cultivars with average, yet consistent, yield are generally more valuable than those with outstanding potential, but whose yields fluctuate in time and space. Selections for high performance in an optimum environment, generally, have below-average stability; whereas, selections under less-desirable conditions may result in the development of lines with above-average stability (Beaver *et al.*, 1985; Finlay and Wilkinson, 1963; George, 1975 and Pierce, 1968).

A widely used method to test stability is that of Finlay and Wilkinson (1963); where, a linear regression analysis was used for measuring a genotype's relative response to environmental variability.

The ability of some crop varieties to perform well over a wide range of environmental conditions has long been appreciated by plant breeders. So, genotypes-environment interactions are of a major importance to the plant breeder in developing high yielding and stable cultivars. This interaction is usually present whether the cultivars are pure lines, single-cross or double-cross hybrids. Allard and Bradshaw (1964) coined the terms predictable environment and unpredictable environments. They reviewed the early work on genotype-environment (GXE) interaction and discussed their implication in applied plant breeding. Quantifying the GXE interaction was handled by several plant breeders (Lin *et al.*, 1986). Among the methods widely used, the linear regression received the main attraction due to its simplicity. Eberhart and Russell (1966) developed the two parameters methods to describe cultivar stability. The first parameter is the regression coefficient "b" of cultivar mean on environmental index calculated from the data; where the stable cultivar would have "b" value = 1.0. The second parameter is the deviation from regression S^2_d which should be equal zero for a stable cultivar. A third criterion, that was introduced by Nguyen *et al.*, (1980) and applied by Stoffella *et al.*, (1984); is the use of the determination coefficient r^2 as an indicator to stability. Genotypes with r^2 greater than 0.50 would be considered stable.

Stability of tomato fruit yield was studied by Stoffella *et al.*, (1984); Poysa *et al.*, (1986); Berry *et al.*, (1988), and Ortiz and Izquierdo (1944). They found differences among tomato genotypes in their stability over different environments. They, also reported significant GXE (linear) and significant pooled deviation, suggesting that genotypes had different slopes of regression. The estimated r^2 values in their studies were larger than 50%, indicating that most of the total sum squares for each genotype could be attributed to linear regression. Perkins (1970) observed significant H x Env. and (Pvs H) x Env. interactions, where the regression was often positive and hence in the direction of greater sensitivity to the environment, which means that the alleles conferring greater sensitivity to the environment were dominant more often than the alleles conferring lesser sensitivity. Ebehart and Russell (1966) and Russell (1968) reported differences among maize single crosses for stability of yield performance. They showed that stability of performance of the hybrid appeared to be partly a property of the inbred parent lines. Sprague and Federer (1951), and Eberhart and Russell (1969) reported greater stability of double-crosses (broad genetic basic) over single-crosses (narrow genetic basic) and that the GXE interaction for the double-crosses was much less than that for single-crosses.

Information about the causes of genotype-environment interactions are lacking in tomato. Therefore, the present investigation was carried out to study the genotype x environment interaction effects for fruit yield and its components in 25 genotypes of processing tomatoes (including 5 parents, 10 F1 and 10 F2 of a (5 x 5) half diallel cross and the stability performance of those genotypes as an average of eight different environments in North Egypt.

MATERIALS AND METHODS

This study was carried out during the winter and summer seasons of the years 1996-1999 to develop the genetic materials and to conduct the required evaluation experiments at two locations in Northern Egypt. The first location was Abbies area (Alexandria) as a clay soil and the second one was at the Bangar El-Sokkar area (Nubaria) as a calcareous soil and represent newly reclaimed land.

Development of genetic materials:-

Five selfed processing tomato cultivars, differing in several characters, were chosen as parental materials. In the first season (October 3, 1996), selfing and hybridization among the five parents were carried out in a diallel cross system in one direction to obtain enough seeds of all possible ten hybrids and new seeds of the five selfed parents. In the second season (April 2, 1997), 15 genotypes were used in a series of crosses and selfing to produce the different genetic populations required for the evaluation trials. The F_1 hybrid plants were selfed to obtain the F_2 seeds. New seeds for the original parents and their F_1's were also reproduced.

Evaluation of the genetic genotypes:-

The twenty-five tomato genotypes (5 parents, 10 F_1 generations and their 10 F_2 generations) were evaluated in this study in four successive seasons at two locations (8 environments) as shown in Table (1). A randomized complete blocks design (RCBD), with four replications, was used in all experiments. Each plot contained 20 plants in 2 rows. Each row was 4.0 m long and 1.0 m wide and the plants were spaced at 0.4 m. The recommended cultural practices for growing tomato were followed at the eight experiments.

Data recorded:-

1) Average fruit weight (g): estimated by dividing the total weight of all harvested fruits / plot on their numbers.
2) Fruits number / plant: the total number of all harvested fruits from each plot divided by the number of growing plants / plot.
3) Early yield (kg/plant): the total weight of all harvested fruits / plot in the first four harvests was considered as a reliable measure for early yield.
4) Total yield (kg/plant): the total weight of all harvested fruits in the whole season.

Statistical analysis and estimation of stability parameters:

Combined analysis of variance for the eight environments (2 locations x 4 seasons) was computed as outlined by Al-Rawi and Khalf-Allah (1980) using the SAS program. For the stability analysis, the 2 locations x 4 seasons were treated as eight environments and another combined analysis was calculated as given by Eberhart and Russell (1966). An environmental index (X_i) was calculated as the deviation of the environment (i) from the overall mean of all environments. For each genotype, a linear regression equation was calculated by regressing the genotype (j) mean (Y_{ij}) in an environment (i) on its environmental index (X_i).

Three estimates of stability were calculated from each equation. The first estimate was the regression coefficient (b) and according to Eberhart and Russell (1966) this "b" value is an indicator of stability. If "b" value appeared equal to 1.0 it would indicate that the genotype is stable. The second estimate is $S^2_{y.x}$ which is the s.s. deviation from regression divided by no. of environments-2. The difference between $S^2_{y.x}$ and pooled error is another estimate of stability. the $\frac{\sigma^2_e}{r} = S^2_d$. The third estimate, is the determination coefficient of the linear regression r^2 and if significant it would be an indicator of stability (Gull *et al.*, 1989; Stoffella *et al.*, 1984 & 1995; and Ortiz and Izquierdo, 1994). The components of variance indicated in the expected mean squares were estimated according to Allard (1960). Heritability in the broad sense was calculated as shown by Falconer (1989).

RESULTS AND DISCUSSION

Tomato yield and its components were significantly affected by the environments in which the plants were grown. However, the genotype-location interaction (GxL) was not found significant in all characters, while both genotype-season (GxS) and (GxLxS) were highly significant (Table, 2). These would indicate that the ranks of the 25 genotypes were different from one environment to another. The studied characteristics of the evaluated 25 genotypes, at the eight environments (2 locations x 4 seasons) were quite variable and their means ranged from 20.1 to 32.4 for average no. fruits / plant; from 89.5 to 105.9 g/fruit for average fruit weight; from 0.98 to 1.50 kg/plant for early yield; and, for total yield, from 2.04 to 2.91 kg/plant (Data not shown). Such a result suggested that the used genotype evaluation sites covered a diversed range of favorable and unfavorable environments for production of tomato.

Tomato fruit number, weight, early and total yields data were significantly influenced by genotypes, and the averages of these characters ranged from 13.8, 73.5 g/fruit, 0.73 and 1.84 kg/plant to 38.3, 125.5 g/fruit, 1.52 and 3.14 kg/plant, respectively, as shown in Tables (4-7). However, it should be recognized that selecting the best genotypes can not be based upon the means alone but the stability of these genotypes should be examined.

The analysis of variance for the stability testing is shown in Table (3). The differences between the eight environments were generally highly significant. The linear component of the genotype- environment interaction appeared highly significant, suggesting that, at least, some of the b's values for the 25 genotypes would be significant. Such a result indicated that the responses of the variance genotypes to the change in environment index were different from one genotype to another. Also, the pooled deviation from regression for the 25 regression genotypes were found significant (Table, 3).

According to Eberhart and Russell (1966) a stable genotype is that which has a "b" value insignificantly different from unity (one) and S^2_d value insignificantly different from zero. Estimates of the three stability parameters, b (linear regression coefficient) S^2_d (difference between $S^2_{y.x}$ and pooled error) and r^2 (determination coefficient for the linear regression) for the four characters under study are shown in Tables (4-7).

With regard to total fruit tomato yield (Table 4), all S^2_d values appeared significantly different from zero which indicated that the studied genotypes might be affected by the micro changes in the conditions of each studied environment. The calculated "b" values indicated that 11 genotypes had positive and significantly higher "b" values than unity, indicating their instability across the different environments, with better performances under the more favorable conditions. On the other hand, 14 genotypes had "b" value insignificantly different from one which indicated their stability across the studied environments. Among the five parents, only P_1 had a "b" value = 1.0 and was considered stable according to Finlay and Wilkenson (1963) since "b" did not differ from one. However, P_1 might be considered unstable according to Eberhart and Russell (1969), and Stoffella *et al.*, (1984) since it had a significant S^2_d and an r^2 value less than 50%. Among the F_1 hybrids, only $P_2 \times P_4$ appeared stable, as its b = 1.0. Also, the F_2 generations of $P_2 \times P_3$ and $P_2 \times P_4$ crosses gave b values that did not differ from 1.0.

The estimated r^2 values were all above 0.50, except for only five genotypes, which emphasized the reliability of the analysis to determine the stability of the tested genotypes for total fruit yield. Accordingly, breeders would select the genotypes which combine both high yield and stability. Among the 25 genotypes under test, the F_1 hybrid $P_2 \times P_4$ gave the highest yield (3.14 kg/plant) and its b = 1.03 with $r^2 = 0.72$, indicating its stability for the macro changes in the environment. Among the F_2 generations, $P_2 \times P_4$ was also the highest yielding (2.56 kg/plant) with "b" value of 1.04 and $r^2 = 0.75$.

Although the F_1 hybrid ($P_2 \times P_5$) was high in yield; however, its "b" value was significantly more than 1.0, suggesting its response to the favorable environments; meanwhile, it would be poor under the less favorable environment. Furthermore, the later hybrid possessed also the highest tomato yield in the F_2 generation and showed a similar stability response as that of its

F_1 generation. In conclusion, the hybrid P_2 x P_4 would be recommended for extended production in different environments, including areas with relatively poor production conditions such as in the newly reclaimed areas.

Generally, stability parameters b, S^2_d and r^2 for number of fruits and early yield per plant reflected similar trends as those of total yield per plant. With regard to early yield, Table (5), illustrated that the earliest genotype was the F_1 hybrid P_2 x P_5 (1.52 kg/plant), followed by the F_1 hybrid P_1 x P_2 and P_1 x P_5 (1.49 and 1.43 kg/plant), respectively. The later two hybrids showed better early yields and stability responses under the studied eight different environments, than the rest combinations. In the F_2 combinations group, the populations P_1 x P_2 and P_2 x P_5 had good magnitudes of early yield and stability responses under the different environmental conditions.

Data presented in Table (6) showed that the F_1 hybrid P_2 x P_5 produced the highest number of fruits (38.3 fruits / plant), followed by the F_1 hybrid P_1 x P_5 (36.5 fruits / plant). Both genotypes showed instability across the studied environments and the ability for better performances under the favorable growing conditions. The data of the F_1 and F_2 of these two particular hybrids reflected good vigor and surpassed not only their mid-parental values but also exceeded the value of their highest parent P_5 (24.8 fruits / plant) for that trait.

The biggest fruits (Table, 7) were harvested from P_3, the F_2 hybrid P_3 x P_4, the F_1 hybrid P_3 x P_4 and P_4 (125.5, 123.0, 122.2 and 121.6 g/fruit, respectively). All the former genotypes reflected stability responses under the different growing environments except P_3. The high stability of fruit weight of the mentioned hybrid populations might be attributed to the high stability of their involved stable parent (P_4). Moreover, the hybrid combination P_3 x P_4 was one of the genotypes that had significant S^2_d values, indicating its response, for this trait, to the mind variation in the conditions within each environment. However, another group of genotypes gave insignificant S^2_d values and showed stability across and within environments, such as the F_1 of P_2 x P_4, accompanied by a relatively high fruit weight.

The partitioning of variance into its components, presented in Table (8), revealed that a large portion of the detected variances for the different characters, was mainly attributable to genotypes. Broad-sense heritability estimates gave some information on the relative magnitudes of genetic and environmental variations (Duldy and Moll, 1969). Heritability percentages ranged from 85.88% for total yield upto 97.23% for fruit weight. Depending on these points of view, when the relatively high or moderate estimates of heritability suggest relatively high or moderate estimates of expected genetic advance for selection. It worth mentioning that the estimated heritability percentage, herein, reflected a greater importance for the non-additive gene effects on the inheritance of these characters; as reported by Khalf-Allah (1970) and confirmed by the finding of Gibrel *et al.*, (1982), who reported that non-additive gene effects and genotype-environmental interactions were more important in the determination of high yield than the additive gene effects.

Comparing the means of the b's values for the three groups of genotypes (parents, F_1's and F_2's), indicated that the average regression for the three groups were almost similar especially for total yield. It was expected that the F_2's would be more stable than the F_1 due to their genetic heterogeneity. However, this trend was not realized. This would indicate that stability in the present materials is due to specific genes for stability. This would be supported by the persistence stability showed by both the F_1 and F_2 generations of the $P_2 \times P_4$.

Plant breeders should consider stability analysis as a sound method of identifying tomato cultivars or selecting advanced breeding lines for adaptability to divers environmental production conditions.

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Table (1): Seasons, sowing transplanting date in each location, average of temperature and relative humidity (RH) for eight environments in Northern Egypt.

Environment	Season	Sowing date	Transplanting date	Location	Air temperature*		R.H*
					Max.	Min.	(%)
E_1	Winter 97/98	October5,1997	November 14,1997	Abbies caly	22.2	9.6	62.8
E_2	Summer 98	May6,1998	June10,1998	"	34.1	24.2	71.6
E_3	Winter98/99	October1,1998	November10, 1998	"	19.6	9.5	65
E_4	Summer99	My10,1999	June15, 1999	"	32.7	20.4	73.6
E_5	Winter97/98	October5,1997	November 8, 1997	Bangar El-Sokkr calcareous	23.7	13.4	68
E_6	Summer98	May6,1998	June 5, 1998	"	-	-	-
E_7	Winter98/99	October1,1998	November 4, 1998	"	19.2	6.0	68
E_8	Summer99	My10,1999	June 10, 1999	"	33.2	15.7	70.3

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Table 2. Combined analysis of variance for the 25 genotypes evaluated in 2 locations over 4 seasons.

S.O.V.	d.f.	MS			
		No. fruits/plant	Fruit weight	Early yield	Total yield
Location (L)	1	7788.58**	1634.18**	9.03**	90.38**
Season (S)	3	597.03**	6945.90**	2.83**	1.60**
L x S	3	34.21**	1318.90**	1.59**	0.64**
Rep / L x S	24	3.11	72.24	0.01	0.004
Genotypes (G)	24	1151.54**	6800.40**	1.207**	5.762**
G x L	24	30.14	15.83	0.016	0.108
G x S	72	101.46**	187.57**	0.281**	0.868**
G x L x S	72	17.86**	48.92**	0.018**	0.125**
Error	576	0.438	19.14	0.0018	0.003

** indicates significance at the 0.01 level of probability.

Table 3. Combined analysis of variance for the stability analysis.

S.O.V.	d.f.	MS			
		No. Fruits/plant	Fruit weight (g)	Early yield (kg/pl.)	Total yield (kg/pl.)
Environment (E) linear	1	1811.76**	3775.50*	3.185**	13.870**
Genotypes (G)	24	1151.54**	6800.40**	1.207**	5.762**
G x E (linear)	24	114.73**	199.65**	0.0525**	0.2182**
Pooled deviation	150	43.74**	84.11**	0.1372**	0.4590**
Pooled error	576	0.438	19.14	0.0018	0.003

** indicates significance at the 0.01 level of probability.

Table 4. Mean, regression coefficient (b), deviation from regression (S^2_d), and the determination coefficient (r^2) for fruit total yield trait of 25 processing tomato genotypes.

Genotypes	Mean	b	S^2_d	r^2
Parents				
P_1	1.87	1.02	0.209**	0.44
P_2	2.05	1.27*	0.039**	0.87
P_3	1.76	0.57	0.366**	0.12
P_4	1.84	0.76	0.024**	0.79
P_5	1.84	1.33*	0.102**	0.73
F_1 generation				
$P_1 \times P_2$	2.99	1.30*	0.195**	0.58
$P_1 \times P_3$	2.63	0.88	0.061**	0.67
$P_1 \times P_4$	2.80	1.35*	0.136**	0.68
$P_1 \times P_5$	2.86	1.24*	0.126**	0.66
$P_2 \times P_3$	2.97	1.13*	0.159**	0.56
$P_2 \times P_4$	3.14	1.03	0.067**	0.72
$P_2 \times P_5$	3.13	1.09*	0.083**	0.69
$P_3 \times P_4$	2.94	0.68	0.304**	0.19
$P_3 \times P_5$	2.98	0.59	0.099**	0.36
$P_4 \times P_5$	2.88	0.78	0.009**	0.91
F_2 generation				
$P_1 \times P_2$	2.39	1.15*	0.122**	0.64
$P_1 \times P_3$	2.19	0.88	0.043**	0.74
$P_1 \times P_4$	2.33	1.24*	0.071**	0.78
$P_1 \times P_5$	2.34	1.09*	0.139**	0.58
$P_2 \times P_3$	2.32	1.04	0.082**	0.68
$P_2 \times P_4$	2.56	1.04	0.059**	0.75
$P_2 \times P_5$	2.51	1.18*	0.066**	0.77
$P_3 \times P_4$	2.26	0.73	0.239**	0.26
$P_3 \times P_5$	2.39	0.87	0.046**	0.72
$P_4 \times P_5$	2.32	0.81	0.002**	0.98
LSD	0.03			

* b value is significantly higher than 1.0 at the 0.05 prob. Level.

** significantly higher than $\frac{\sigma^2_e}{r}$ at the 0.05 prob. Level.

Table 5. Mean, regression coefficient (b), deviation from regression (S^2_d), and the determination coefficient (r^2) for early yield trait of 25 processing tomato genotypes.

Genotypes	Mean	b	S^2_d	r^2
Parents				
P_1	1.07	-0.39	0.093**	0.06
P_2	1.18	0.70	0.023**	0.45
P_3	0.85	1.08	0.006**	0.88
P_4	0.73	1.18*	0.029**	0.65
P_5	1.01	1.23*	0.011**	0.84
F_1 generation				
$P_1 \times P_2$	1.49	0.56	0.018**	0.39
$P_1 \times P_3$	1.30	0.70	0.011**	0.61
$P_1 \times P_4$	1.22	0.68	0.263**	0.07
$P_1 \times P_5$	1.43	0.87	0.033**	0.47
$P_2 \times P_3$	1.39	1.21	0.016**	0.77
$P_2 \times P_4$	1.34	1.04	0.005**	0.88
$P_2 \times P_5$	1.52	1.57*	0.024**	0.79
$P_3 \times P_4$	1.09	1.67*	0.035**	0.75
$P_3 \times P_5$	1.26	1.99*	0.082**	0.65
$P_4 \times P_5$	1.17	1.66*	0.037**	0.74
F_2 generation				
$P_1 \times P_2$	1.29	0.41	0.027**	0.19
$P_1 \times P_3$	1.09	0.58	0.007**	0.01
$P_1 \times P_4$	1.08	0.18	0.019**	0.06
$P_1 \times P_5$	1.18	0.83	0.007**	0.77
$P_2 \times P_3$	1.17	0.98	0.007**	0.83
$P_2 \times P_4$	1.12	0.81	0.006**	0.78
$P_2 \times P_5$	1.26	1.05	0.012**	0.78
$P_3 \times P_4$	0.91	1.36*	0.022**	0.76
$P_3 \times P_5$	1.09	1.54*	0.027**	0.77
$P_4 \times P_5$	1.01	1.49*	0.026**	0.77
LSD	0.02			

* b value is significantly higher than 1.0 at the 0.05 prob. Level.

** significantly higher than $\frac{\sigma^2_e}{r}$ at the 0.05 prob. Level.

Table 6. Mean, regression coefficient (b), deviation from regression (S^2_d), and the determination coefficient (r^2) for number of fruits/plant trait of 25 processing tomato genotypes.

Genotypes	Mean	b	S^2_d	r^2
Parents				
P_1	21.8	1.35*	19.50**	0.66
P_2	21.6	1.28*	6.48**	0.84
P_3	13.8	0.09	18.20**	0.01
P_4	14.7	0.29	5.66**	0.23
P_5	24.8	1.61*	23.90**	0.69
F_1 generation				
$P_1 \times P_2$	33.6	1.57*	24.24**	0.68
$P_1 \times P_3$	25.6	0.71	3.46**	0.75
$P_1 \times P_4$	27.7	1.34*	4.86**	0.88
$P_1 \times P_5$	36.5	1.65*	11.30**	0.83
$P_2 \times P_3$	27.8	0.85	7.38**	0.67
$P_2 \times P_4$	29.7	1.03	5.34**	0.81
$P_2 \times P_5$	38.3	1.53*	15.17**	0.76
$P_3 \times P_4$	23.8	0.09	20.83**	0.01
$P_3 \times P_5$	31.0	0.65	10.63**	0.46
$P_4 \times P_5$	31.8	0.93	8.48**	0.67
F_2 generation				
$P_1 \times P_2$	26.2	1.18*	14.60**	0.67
$P_1 \times P_3$	21.3	0.73	2.78**	0.79
$P_1 \times P_4$	22.8	1.24*	3.35**	0.90
$P_1 \times P_5$	30.0	1.53	14.28**	0.78
$P_2 \times P_3$	21.8	0.81	5.16**	0.72
$P_2 \times P_4$	24.2	1.04	4.34**	0.84
$P_2 \times P_5$	30.3	1.38*	12.86**	0.76
$P_3 \times P_4$	18.4	0.19	18.15**	0.04
$P_3 \times P_5$	25.61	0.98	5.70**	0.78
$P_4 \times P_5$	25.6	0.98	3.97**	0.83
LSD	0.33			

* b value is significantly higher than 1.0 at the 0.05 prob. Level.

** significantly higher than $\frac{\sigma^2_e}{r}$ at the 0.05 prob. Level.

Table 7. Mean, regression coefficient (b), deviation from regression (S^2_d), and the determination coefficient (r^2) for fruit weight trait of 25 processing tomato genotypes.

Genotypes	Mean	b	S^2_d	r^2
Parents				
P_1	86.6	0.51	-1.44	0.73
P_2	96.2	1.50*	25.29**	0.73
P_3	125.5	1.57*	24.34**	0.75
P_4	121.6	0.21	176.25**	0.01
P_5	73.5	0.52	-3.59	0.89
F_1 generation				
$P_1 \times P_2$	89.7	0.68	10.38**	0.52
$P_1 \times P_3$	102.8	1.44*	1.05	0.93
$P_1 \times P_4$	101.4	0.79	10.44**	0.60
$P_1 \times P_5$	78.5	0.47	3.32	0.84
$P_2 \times P_3$	107.5	1.95*	15.3**	0.87
$P_2 \times P_4$	106.2	1.29	0.37	0.92
$P_2 \times P_5$	82.3	1.12	0.79	0.89
$P_3 \times P_4$	122.2	0.60	9.68**	0.47
$P_3 \times P_5$	94.0	1.69*	13.63**	0.85
$P_4 \times P_5$	91.5	1.31*	35.83**	0.60
F_2 generation				
$P_1 \times P_2$	91.5	0.59	4.12	0.58
$P_1 \times P_3$	103.0	1.47*	1.48	0.92
$P_1 \times P_4$	102.2	0.88	4.06	0.76
$P_1 \times P_5$	78.3	0.56	-4.15	0.95
$P_2 \times P_3$	108.0	1.96*	16.22**	0.87
$P_2 \times P_4$	106.5	1.37*	0.82	0.92
$P_2 \times P_5$	83.6	0.99	10.57**	0.69
$P_3 \times P_4$	123.0	0.92	11.67**	0.65
$P_3 \times P_5$	94.1	1.79*	9.06**	0.89
$P_4 \times P_5$	92.3	1.38*	37.08**	0.62
LSD	2.19			

* b value is significantly higher than 1.0 at the 0.05 prob. Level.

** significantly higher than $\frac{\sigma^2_e}{r}$ at the 0.05 prob. Level.

Table 8. Estimates of variance components of genotypes (σ^2_g), genotype x season (σ^2_{gs}), genotypes x location (σ^2_{gl}), genotypes x location x season (σ^2_{gls}), environment (σ^2_e) and hertability (H%) and genetic advance (GA) for the studied characters.

Characters	σ^2_g	σ^2_{gs}	σ^2_{gl}	σ^2_{gls}	σ^2_e	H%	GA
Fruits/plant	32.43	10.45	0.768	4.356	0.438	90.13	11.12
Fruit weight	205.62	17.33	0.000*	7.445	19.14	97.23	29.05
Early yield	0.023	0.033	0.000*	0.0041	0.0018	93.49	0.30
Total yield	0.146	0.093	0.000*	0.031	0.003	85.88	0.61

* negative estimates for which the most reasonable value is zero.

$$\sigma^2_A = \sigma^2_g + \frac{\sigma^2_{gs}}{s} + \frac{\sigma^2_{gl}}{l} + \frac{\sigma^2_{gls}}{ls} + \frac{\sigma^2_e}{rls}$$

$$H\% = \frac{\sigma^2_g}{\sigma^2_A} x \ 100$$

GA = (k) (σ^2_A) (H %)

الملخص العربي

هجن طماطم جديدة للتصنيع ومدى ثباتها تحت ظروف الأراضي الجديدة بشمال مصر

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أجريت هذه الدراسة لتقدير الثبات المظهرى لعدة صفات هامة فى الطماطم وهى صفة عدد الثمار / نبات ووزن الثمرة والمحصول المبكر والمحصول الكلى. وذلك فى ٢٥ عشيرة وراثية تتضمن ٥ أصناف (آباء) و ١٠ هجن جيل أول (جميع التهجينات الممكنة بين الآباء فى اتجاه واحد) و ١٠ هجن جيل ثانى (الجيل الإنعزالى الأول). وزرعت هذه العشائر فى منطقتين أبيس (الإسكندرية) وبنجر السكر (النوبارية) وفى الموسمين الشتوى والصيفى لعامى ٩٧ / ١٩٩٨ ، ٩٨ / ١٩٩٩. ولقد أستخدمت طريقة حساب الارتداد لتقدير مقاييس الثبات التالية b و S^2_d و r^2 تحت الظروف البيئية الثمانية المختلفة (منطقتين × ٤ مواسم). أوضحت النتائج أن الهجين ($P_2 \times P_4$) قد أعطى أعلى محصول كلى (٣,١٤ كجم / نبات) عن باقى الهجن وكذلك عن كل العشائر تحت الدراسة، وتميز هذا الهجين بان كل الصفات المدروسة قد عكست ثباتا تحت الظروف البيئية المختلفة. كما أن الجيل الانعزالى الأول (الجيل الثانى) لهذا الهجين $F_2(P_2 \times P_4)$ قد أعطى أيضا أعلى محصول كلى بين باقى مجاميع F_2 (٢,٥٦ كجم / نبات). أما الهجين الأول $F_1(P_1 \times P_3)$ فعكس ثباتا فى صفات المحصول الكلى وعدد الثمار / نبات والمحصول المبكر، بينما الهجين الأول $F_1(P_3 \times P_4)$ فقد عكس ثباتا فى المحصول الكلى وعدد الثمار/ نبات بالإضافة لصفة وزن الثمرة. علما بأن درجة التوارث فى صفات المحصول الكلى وعدد الثمار / نبات والمحصول المبكر ووزن الثمرة فقد قدرت بالقيم ٨٥,٨٨ ، ٢٠,١٣ ، ٩٣,٤٩ ، ٩٧,٢٣% على التوالى. ويستفيد مربى النبات من نتائج دراسة الثبات فى تصنيف الأصناف على أساس ثبات الصفات الهامة كالمحصول ومكوناته ودرجة الأقلمة ضد البيئات المختلفة. لذلك فمن خلال دراسة الثبات يمكن الاستفادة من ارتفاع قيمة الأصناف الهامة فى إنتاج الهجن المتميزة محصوليا كما ونوعا، بالإضافة لتميز الهجن بثبات هذه الصفات وكذلك يمكن إنتاج سلالات ثابتة محصوليا واستخدامها فى تراكيب هجينية أخرى جديدة.