Comparative study in fifteen genotypes of tomato for heat tolerance under Upper Egypt conditions

Rashwan, A.M.A

Department of Hort. (vegetable crops), Fac. of Agriculture, South Valley University
rashwan_univ@yahoo.com

Abstract: The present investigation was carried out at south valley university experimental Farm during the two seasons 2013/2014 and 2014/2015. The objective of this investigation was to compare 15 genotypes in tomato for heat stress tolerance under Upper Egypt conditions, as well as genotypes tolerant to heat, more stable, high yield, and grown under upper Egypt conditions in future, also, it can be used in breeding program. The 15 genotypes of tomato were grown at two different sowing date [10 July (favorable = SDF) and 10 Febr. (heat stress = SDH)] in every season. Genotypes and GxE interaction mean squares showed highly significant values for all studied traits under SDF and SDH conditions. Genotype No. 3 (line Sv1) exhibited highest mean for YP, NFL, NF and WF followed by No. 4, No. 9 and No. 6 for fruit set % under SDF and SDH conditions. Also, Genotypes No. 1, 3, 4, 6, 9, 12 and 14 were relatively heat resistance (Hsi values<1), while other genotypes were relatively susceptible to heat stress (Hsi values>1). SDS compared with SDF conditions, showed decreasing by 13.6% (NFP), 38.6% (NF), 20.7% (FS) 17.5% (WF) and 37% (YP). According to (D/I %) for genotypes No. 1, 3 and 4 recorded the highest stable value under SDS and SDF for all studied traits followed by No. 9, No. 10 and No. 11. The results indicated that there are an essential amount of genetic variance for each trait and high heritability for all studied traits. Significant and positive were observed between YP and NFP, FS%, WF traits, also, FS% and NFP, NF under SDS and SDF in both seasons. Possible to determine the four genotypes (No. 3, N.4, 9, 1) of high yield, and more stable, suitable for sowing under heat stress conditions in Upper Egypt.

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Key words: Genotype, GxE interaction, heat stress, Genetic variance, correlation.

1. Introduction

High temperatures is the most important determinants of the continuity of the production of the tomato crop in southern Egypt in the summer season, In addition to most of the genotypes in Egypt and the countries of the world are sensitive to high temperature, and very few of these genotypes is tolerant to high temperature. In Egypt, the tomato is on of the important crops daily consumption, it is the poor and the rich food. As well as tomatoes are grow in all regions of Egypt from north to south. Generally in Upper Egypt, average temperature in April 35.9°c and 32.49°c to 41.27°c and 43.13°c in July in the summer season 2014 and 2015 Table 2. Hassen (1991) indicated that, tomates are considered of the warm season, it needs to warm growing season, free forest , and the favorable temperature ranged from 18°c to 29°c. No growth at temperature below 10°c, and with the high temperature for that growth rate gradually increase until it reaches 30°c, where lead exposure plants of this degrees for a long time to make a small leaves, stems weak on the contrary, tomato plants that grow under relatively low temperature conditions, leaves are large, dark green color leaves, stem thick. No growth at a constant temperature at more than 35°c. low temperature of 13°c for the night leads to the death of most of the pollen and stop fruit set. The night temperature in excess of 21°c or the day of more than 32°c reduced fruit set.

Heat stress (HS) effect tomato plant through of (Laek of carbonhydrates in the plant level, non-transmission of carbohydrates in plant composition, few flowers, weakness produce pollen, lack of pollen dispersal, weak vitality and germination of pollen, weakness vital eggs, emeragence of the stigma from tube stamen, dry stigmas) resulting a decrease in fruit set and reduced of the yield/ plan (Abdalla, and Verkerk 1968; El-Ahamdi and Stevens 1979; Kuo et al., 1979; Dinar and Rudich 1985; Stevens and Rick 1986; Abdul-Baki 1991; Hassen 1993; Hassen 1995; Peet et al., 1996; Asif et al. 2007; Ahmed et al, 2010; El-Sayed et al. 2010; Kamel et al. 2010 and Islam 2011).

High temperature decreased the yield plant, number of fruit and fruit weight (Hanna and Hernaandez 1982; Berry et al. 1988; Adams et al. 2001 and Islam 2011). Genetic variability of fruit set, fruit weight, and yield in a tomato population growth in tow high- temperature environments were studied by Linda and Scott (1991), they found that yields/plant under heat stress may increase with selection for fruit set, but a reduction in fruit weight would be expected in this population and those with similar genetic correlations. High temperature that exceeded 35°c during the summer month of June resulted in poor fruit set in Nadi of Pakistan, Sayed et al. 2001. Aref and Abdul-Baki (1991), indicated that high-temperature decreased fruit set, yield plant and flower abscission. An additive genetic system with complete dominance for fruit cluster/ plant, number of fruits/plant and fruit yield/ plant Ahmed et al. (2010) under heat stress. Rudich et al. (1977) showed that the percentage of fruit set under temperature conditions 29/22 (day/ night) ranged from 56 to 60% in Saladette cv; while ranged from 0 to 22% in sensitive cultivars to high temperature. Another study by Adil et al. (2003) observed that the number of pollen grains produced by the heat tolerant genetypes in tomato, were higher than the numbers produced by the heat sensitive genotypes. Stigma exeration, reduction in pollen fertility, increased flower drop, decreased fruit numbers, fruit weight and fruit yield were observed under high temperature are in all genotypes Borogohain and Swargiary (2008). Asif et al. (2007) revealed that genotype "Cchaus" had maximum fruit yield (2703 g) produced during the high temperature conditions among genotypes, while "Rome" cv. Produced fruit yield (66.9/ plant) and the rest genotypes produced yielding ranged from 448.3 to 2295.9/ plant. Rivero et al. (2004) observed that heat stress in summer seasons is on of the most important abiotic environmental affect on tomato fruit set. Vegetative development in tomato less sensitive to high temperature than the reproductive development Soylu and Comlekcioglu (2009).

In Egypt, evaluated 105 lines and cultivars of tomatoes under heat stress conditions in summer (June and July) in governorate of Giza and Qaliubya, results indicated that more cultivars productivity and the ability to fruit set in the high temperatures were (Punjab, UC82 and Peto 81), and Saladiate cv. Of the best genotype for the ability to fruit set under heat stress (Radwan et al., 1986). Partial dominance was found for fruit set % trait under heat stress Shelby et al., (1979) fruit set % is complex trait Villareal and Lai (1979).

Increase or decrease of the yield/ plant tomatoes in different sowing dates in Egypt, because there are extreme environmental changed (HS). Heat stress is considered one of the most important factors affecting the fruit set and yield/Plant. Tomato is grown in Egypt under diverse environmental conditions with the seasonal fluctuations in yield posing a challenge to tomato breeders and growers. Differences between tomato genotypes in their response to changes in the environment (genotype environment interaction) has been reported for yield and its components (Linda and Scott, 1992; Ahmed et al 2009; Ashrafuzzaman *et al.*, 2010; Rosello *et al.*2011; Hossain *et al.*2013). Evidently, stabilization of tomato production requires varietal stability and adaptability to environmental fluctuations. Developing such tomato genotypes is only Feasible through incorporating the study of GxE interaction as an integral par of the breeding program.

Since tomato growers are generally interested in varieties which show consistently high performance over years, sowing dates, such factors should be represented in the range of environments over which varietal stability is assessed. Simultaneous consideration of both yield and stability of performance will reduce the effect of GxE interaction and will make selection of genetypes precise and refined (King and Pham, 1991). The objectives of this study was to compare fifteen genotypes in tomato for heat stress tolerance under upper Egypt conditions, as well as genotypes tolerant to heat, more stable, high yield, and grown under Upper Egypt , also, it can be used in breeding program.

2. Materials and Methods

Field experiment were conducted at south valley university experimental farm during two seasons 2013/2014 and 2014/2015, to compare 15 genotypes in tomato for heat stress tolerance under Upper Egypt conditions. Fifteen different genotypes of tomato (cultivars, lines, hybrid) were used in this study. The genotypes and their sources are presented in Table 1.

Table 1: Name and source of the tomato genotypes used in the study.

No.	Genotypes (cultivar/lines/ hybrid)	Source
1	Castl Rock (cultivar)	**
2	Pakmor (cultivar)	
3	Sv_1 (line)	*
4	Sv_2 (line)	
5	Sv_3 (line)	
6	Sv_4 (line)	
7	Sv_5 (line)	
8	Sv_6 (line)	
9	Sv_7 (line)	
10	Sv_8 (line)	
11	HZ9144F1 (Hybrid)	**
12	NSX6141F1 (Hybrid)	
13	KENANHF1 (Hybrid)	
14	TY-F_1 (Hybrid)	
15	Hal F_1 (Hybrid)	

*Sv: South valley, Egypt.
**ARC: Agricultural Research center, Egypt.

Seeds were sown in nursery on [10 July (SDF = Favorable) and 10 February (SDH = heat stress)] conditions. Transplants were set on side of the ridge/ meter width and 5m long, with 30 cm between transplants. Each experimental unit consisted of 4 ridges. The genotypes were arranged in a randomized complete block design (RCBD) with three replications. The monthly average temperature during seasonal growth 2014 and 2015 are shown in Table 2. The common recommended Cultural practices for the commercial production of tomato were conducted.

Ten plants were taken at random to determine the means of following characters in all genotypes under SDF and SDF conditions:
1- Number of flowers/ plant (NFL)
2- Number of fruits / plant. (NF)
3- Fruit set % .(FS%)
4- Weight of fruit. (WF)
5- yield/ plant (g) (YP).

Table 2: The monthly average temperature during seasonal growth 2014 and 2015

Month	Temperature (C°)				Month	Temperature (C°)			
	2014		2015			2014		2015	
	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.
January	23.78	8.57	22.26	7.73	July	41.27	26.73	43.13	25.72
February	26.08	10.73	25.09	10.26	August	40.95	26.4	40.50	28.23
March	29.65	15.06	30.27	15.14	September	39.11	24.08	40.60	26.14
April	35.90	20.1	32.49	16.23	October	31.01	19.63	35.89	22.65
May	38.42	23.1	38.01	22.68	November	28.46	14.37	28.47	15.17
June	40.57	25.55	39.66	24.99	December	25.46	11.53	16.77	6.83

Heat susceptibility index (HSI)

The heat susceptibility index (HSI) was used as a measure of heat tolerance in terms of the reduction in yield caused by unfavorable (SDH) and favorable (SDF) environments. HSI was calculated for each genotype according to the formula of Fisher and Muarer (1978).

$$HSI = 1 - \frac{\overline{Yh}}{\overline{Yp}}$$

Were $\overline{Yh}$ = mean yield of all genotypes under heat , $\overline{Yp}$ = mean of all genotypes under favorable conditions, H = heat stress

$$HSI = \frac{YP - Yh}{YP.HSI}$$

Were YP = mean yield of individual genotype under favorable, yh = mean yield of individual genotype under heat stress.

Genotype with average susceptibility or resistant to heat will have an HIS value of 1.0. values less than 1.0 indicate susceptibility and greater resistance to drought. Meanwhile, a values of HIS = 0 indicate maximum possible heat tolerance (no effect of heat on yield).

Decrease or increase % (D / I %) = $\frac{SDF - SDH}{SDF} \times 100$

Where

D / I % = the relationship between the impact of SDF and SDS conditions, so increase or decrease in the calculated value of each genotype environmental

SDF = Sowing date under favorable environmental

SDS = Sowing date under heat stress environmental

Analysis of variance

Data were statistically analyzed according to (Gomez and Gomez, 1984). Comparison among means of all genotypes tomato were tested using LSD values at 5% and 1% levels. Heritability were estimated according to Johnson *et al.* (1955).

3. Results and Discussion

GE interaction and heat susceptibility index for YP.

The combined and separate analysis of variance for all studied traits showed highly significant differences among the 15 genotypes, indicating the wide diversity between the genotypes materials used in this study and the presence of true differences among the genotypes Table 3. On the other hand, high significant differences among GxE interaction effect were found for all studied traits, reflecting the drastic effect of varying environments among two sowing dates (favorable and heat stress) in seasons besides the differential responses of the tested genotypes. Great attention of breeders worldwide has been given to this crop. Wide range of variability among tomato cultivars germplasm in yield and its constituting traits under heat stress (Radwan *et al.,* 1986; Hossain *et al.,* 1986; Sam and Iglesias, 1994; Haque *et al..* 1999; Rosello *et al.,*2011; Marbhale 2016). Another study by Hossain *et al.* (2013) found the yield and its components of tomato was significantly affected by different sowing dates and tomato genotypes.

According for YP, heat susceptibility index (HSI) was estimated for each of the 15 genotypes tested. Eight genotypes (No 2, 7, 8, 10, 11, 13 and 15) displayed HSI values >1 indicating relative susceptibility to heat stress. On the other hand, the other genotypes displayed His values < 1 with relative resistance to heat stress. Generally, the best mean performance over the two environments was displayed by genotypes No 5, 7, 8 and 10. Linda and Scott (1992), found that GxE interaction was significant for yield and fruit set % under grow in two high temperature environments. Plants growing under heat stress (transplanted on May 5) had reduced fruit production and yield plant Ahmed *et al.* (2009). Interaction effect between seasons and genotypes were significant for number of flowers/ cluster, number of fruits/ cluster, number of fruits/ plant, fruit yield/ plant. Mean squares due to genotypes (Land races), environments (years) and genotypes environment interaction were highly significant ($P \leq 0.01$) for most characteristics studied Firas (2013). In this context, Ummyiah *et al.* (2015), Stated that significant differences were observed among all the hybrids for eight quantitative characters, also the interaction component genotype × environment was also significant for all the traits.

Minimum value for NFP ranged from 63.33, 54.66 and 61.52, 66.0 to maximum 79.0, 69.0 and 80.0, 80.0 with average 71.73, 62.0 and 71.55, 61.71 under SDF and SDH in both seasons Table 5 and 6. Line SV_1 gave the highest value under SDH in both seasons followed by line Sv_7. Heat stress decreasing for NFP by value 13.35% and 13.75% in both seasons. Similar results were reported by (Rylski, 1979; Hanna and Hernandez 1982 and Borogohain and Swargiary 2008) they found that increasing flower drop under high temperature. Another study by Aref and Abdul-Baki (1991) high temperature decreasing number of flowers/ plant by values 38% and 68% in tolerant and sensitive cultivars.

Under favorable and heat stress conditions, Maximum value for NF ranged from 44.0, 34.0 and 44.66, 34.66 in both seasons. The NF value decreasing by 27.79% and 27.76% in both seasons. Line Sv_1 followed by line Sv_2 recorded highest values under SDH conditions. The highest fruit set % values (61.68, 53.92 and 62.12, 53.84) were obtained from line Sv_4 under SDF and SDH conditions in both seasons.High temperature during the summer seasons resulting in a decrease of fruit set % with 16.53 and 16.48% in both seasons. These results are in agreed with the findings of (Aref and Abdul-Baki 1991; Linda and Scott 1992; Syed *et al.,* 2001; Adil *et al.,* 2003 *et al.,* 2004 and Borogohain and Swargiary 2008). They found that high temperature decrease fruit set %, and (Berry *et al.,* 1988 and Islam 2011) observed that heat stress reduce the number of fruits and fruit set %. The highest FW (130.0, 115.0 and 131.33, 94.33 g) was found in line Sv_1, while the lowest value were (65.0, 56.0 and 66.33, 57.33) for genotype No. 14 under SDF and SDH conditions in both seasons. Heat stress for WF caused a decrease by 22.48% and 12.60% in both seasons. The maximum average YP was observed for line Sv_1 followed by, line Sv_2, line Sv_4 and line Sv_7 under SDF and SDH in both seasons. High temperature during the summer seasons, resulting in a decrease YP by 37.775 and 38.0% under conditions Upper Egypt. This lack of yield/ plant is a result of heat stress and its impact on physiological processes in different genotypes under SDH. These results are in accordance with those reported by (Levy *et al.,* 1978; Berry *et al.,* 1988; Abdul- Baki 1991; Linda and Scott 1992; Mohamed and Hewedy 1994; Adams *et al.,* 2001; Christakis and Fasoules 2002; Adil *et al.,* 2003; Netwally *et al.,* 2004; Asif *et al.,* 2007; Ahmed *et al.,* 2009; Ashraf Fuzzaman *et al.,* 2010; Islam 2011 and Hossain *et al.,* 2013) who found that high temperature reduced the fruit weight and yield/ Plant. According to estimate the relative to %, SDS compared with SDF conditions, showed decreasing by 13.6% (NFP), 38.6% (NF), 20.7% (FS), 17.5% (WF) and 37% (YP) Table 7. Genotypes No. 1, 3 and 4 recorded the highest value under SDS and SDF for all studied traits followed by No. 9, No. 10 and No. 11 Table 7.

Genetic Parameters:

The relative magnitude of genotypic variance ($\sigma^2 g$) was slight to large compared to variance ($\sigma^2 e$), reflecting to genetic differences among the tested genotypes for all studied traits under SDF and SDH conditions in both seasons Table 8. These results indicated that substantial amounts of genetic variance were obtained for all studied traits at two seasons. GVC% ranged from 7.89, 8.64% and 6.73, 7.53 for NFP to 24.57, 27.80% and 24.59, 28.30 for YP trait under SDF and SDH in both seasons Table 8. High heritability were found for all studied traits including yield/ Plant and its components under SDF and SDH in both seasons Table. These results confirms the previously reported heritability in tomato (Kamel *et al.,* 2010) under Egypt conditions Table 8. Similar high of heritability were also noticed by several other workers in different regions of the world (Linda and Scott 1992; Kummaria and Subramanian, 1994; Natarajan 1994; Padmini and Vadivel, 1997; Pradeepkumare *et al.,* 2001; Mohanty 2003; Haydra *et al.,* 2007; Hidaya *et al.,* 2008; Ghosh 2010. And Jiregna *et al.,* 2011 and Rashwan 2015).

Correlations

The YP has a positive and significant correlated with NFP trait (0.905** and 0.84**), FS% (0.759** and 0.712**) and WF (0.783 and 0.729**) under SDF and SDH in both seasons, Table 9, respectively. Significant and positive correlated was observed between WF and FS (0.893** and 0.910**). Nigative and significant correlation was found between WF and NFP (-0.548** and -0.461**) under SDF and SDH. Fruit set % was positively and significant correlated with NFP (0.548** and 0.440**) and NF (0.307** and 0.387**) under favorable and heat stress. Previous findings suggested that it could be the improving of YP under heat stress (HS) conditions through selection for Fs%, NFP and WF traits. Also, improving the fruit set % is through selection for NFP and NF traits under heat stress conditions. Such relations indicate that the possibility of combining genotypes with high fruit set % and high YP by selection for number of NFP, NF and WF under heat stress in Upper Egypt. Fruit weight/ Plant showed high and positive genotypic and phenotypic correlation with number of fruits/ Plant Hidaya *et al.* (2008). Number of fruits/ plant showed significant and positive correlation with mean fruit weight Mohanty (2002). Another study by Haydar *et al.* (2007), observed that highest direct correlation between number of flowers and yield/ Plant. Genetic correlations between fruit set % and yield were strongly positive, while those between fruit set% and fruit weight, were negative under heat stress conditions. Also, Selection for fruit set % under high temperature would result in increased yield, but reduced fruit weight Linda and Scott (1992). Also, these results were in agreement with the finding of (Curtero and Cubero 1982; Hanna and Herndez 1982; Shen and Li 1982; El-Ahmadi and Stevens 1979 and HArer and Bhor 2003).

Table 3: Analysis of variance for all studied traits tomato under condition two sowing dates (flavorable = SDF and heat stress = SDH) in tow seasons.

Characters S.O.V	Df	Mean Squares 1st									
		NFL		NF		FS		WF		YP	
		SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH
Replication	2	12.867	0.156	0.600	1.156	13.671	4.666	1.067	2.289	2246.6	1646.66
Genotypes	14	73.200**	68.02**	95.867**	73.403**	178.177**	167.17**	1025.276**	771.946**	449931.19**	234056.19**
Error	28	3.152	2.513	2.838	2.346	6.998	7.642	5.471	2.408	1230.00	708.57
Characters S.O.V	Df	Mean Squares 2nd									
		NFL		NF		FS		WF		YP	
		SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH
Replication	2	0.422	0.422	0.356	0.156	0.241	0.397	0.689	0.822	105.00	528.08
Genotypes	14	94.413**	84.041**	100.61**	86.127**	183.034**	180.30**	1013.927**	733.117**	462633.57**	227248.04
Error	28	0.660	0.637	0.475	0.394	46.047	1.338	1.213	0.703	458.57	190.70

*, ** significant and highly significant at 5% and 1% levels of probability, respectively.

Table 4: Man Squares of the combined analysis of variance for all studied traits under condition two sowing dates (flavorable and heat stress) in both seasons.

Characters S.O.V	Df	Season 1				
		NFL	NF	FS	WF	YP
Environment E	1	2180.54**	2170.71**	1502.43**	3673.61**	8340560.04**
Error	4	0.422	0.256	0.319	0.756	316.54
Genotypes G	4	175.50**	179.31**	346.75**	1722.48**	664430.97**
G × E	14	2.94**	7.42**	16.58**	24.563**	25450.64**
Error	56	0.648	0.435	1.49	0.958	324.64
		Season 2				
Environment E	1	2121.87**	2064.01**	1373.58**	3622.67**	8118010.00**
Error	4	6.51	0.878	9.169	1.678	1946.66
Genotypes G	4	137.24**	164.78**	336.13**	1779.99**	661355.35**
G × E	14	3.97**	4.48**	9.18**	17.22**	22632.02**
Error	56	0.83	0.45	1.7	3.940	969.28

*, ** significant and highly significant at 5% and 1% levels of probability, respectively.

Table 5: Mean values of 15 genotypes as affected by SDF and SDH conditions for all studied traits in two seasons.

Season	Season 1st									
Characters	NFL		NF		FS		WF		YP	
Geneotypes	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH
1	75.00	68.66	31.66	26.66	42.21	38.82	81.33	76.33	1250.00	830.00
2	69.00	59.00	28.33	20.00	41.05	33.89	87.00	75.66	1100.00	590.00
3	79.00	69.00	44.00	34.00	55.69	49.27	130.00	115.00	2200.00	1440.00
4	67.00	61.00	41.33	30.00	61.60	49.18	115.00	98.33	2050.00	1386.66
5	71.33	60.00	39.66	28.00	55.60	46.66	113.33	96.00	1743.33	1073.33
6	65.00	55.00	40.00	29.66	61.68	53.92	116.00	104.66	2104.33	1360.00
7	69.33	60.00	38.00	27.33	54.81	45.55	108.00	94.00	1673.33	1026.66
8	76.00	64.66	40.00	28.66	52.63	44.32	110.00	96.00	1863.33	1150.00
9	79.00	68.00	41.00	30.66	51.89	45.08	114.00	99.00	1913.33	1213.33
10	68.00	56.66	35.00	26.33	51.47	46.47	79.33	69.33	1281.66	776.66
11	75.00	64.66	32.00	23.33	42.66	36.08	77.00	67.66	1123.33	676.66
12	63.33	54.66	26.00	16.00	41.05	29.27	104.00	87.66	1500.00	953.33
13	70.00	60.33	29.00	21.00	41.42	34.80	111.33	97.66	1480.00	880.00
14	77.00	66.66	33.00	21.00	42.85	31.50	65.00	56.00	1008.33	640.00
15	72.00	62.00	30.00	19.33	41.66	31.17	106.66	94.33	1440.00	773.00
Average	**71.73**	**62.01**	**35.26**	**25.46**	**49.21**	**41.06**	**101.19**	**78.44**	**1581.99**	**984.66**
LSD 0.5	**3.30**	**2.96**	**3.14**	**2.86**	**4.93**	**5.17**	**5.58**	**3.68**	**65.70**	**49.87**
LSD 0.1	**4.76**	**4.26**	**4.53**	**4.13**	**7.11**	**7.44**	**6.28**	**4.17**	**94.76**	**71.92**

Table 5: Cont.

Season	Season 2nd									
Characters	NFL		NF		FS		WF		YP	
Geneotypes	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH
1	76.33	68.33	32.66	27.66	42.78	40.48	81.66	76.66	1244.66	830.00
2	70.00	60.00	29.33*	21.33	41.9	35.55	88.00	76.00	1120.00	600.00
3	80.00	70.00	44.66	34.66	55.82	49.51	131.33	115.00	2260.00	1470.00
4	68.66	61.66	41.66	31.66	60.67	51.62	115.66	97.33	2070.00	1360.00
5	72.00	61.33	38.33	27.33	53.23	44.32	114.66	96.33	1770.00	1080.00
6	66.00	56.33	41.00	30.33	62.12	53.87	116.66	105.00	2126.66	1373.33
7	67.33	58.00	36.33	25.33	53.95	43.67	106.66	93.33	1650.00	1013.00
8	74.33	62.00	41.00	26.33	55.15	42.46	111.33	95.33	1800.00	116.66
9	80.00	69.33	41.66	31.66	52.07	45.66	112.66	99.66	1963.33	1210.00
10	69.33	57.33	36.33	27.33	52.40	47.67	80.00	70.00	1310.00	790.00
11	76.00	65.33	31.00	24.33	40.78	37.24	76.66	68.33	1156.66	690.00
12	64.33	55.66	26.66	16.33	41.44	29.33	105.00	87.33	1583.33	970.00
13	71.00	61.00	30.33	21.00	42.71	34.42	110.66	96.33	1503.33	939.66
14	61.00	52.66	31.33	19.33	51.36	36.70	66.33	57.33	1005.00	663.33
15	76.66	66.66	28.33	18.33	36.95	27.49	103.00	94.33	1420.00	770.00
Average	**71.55**	**61.71**	**35.37**	**25.5**	**49.55**	**41.38**	**101.35**	**88.57**	**1599.66**	**991.73**
LSD 0.5	**1.92**	**1.90**	**1.63**	**1.48**	**3.05**	**2.75**	**2.62**	**1.98**	**51.05**	**33.13**
LSD 0.1	**2.60**	**2.56**	**2.20**	**2.00**	**4.09**	**3.70**	**3.54**	**2.67**	**68.00**	**44.40**

Table 6: Range and $\overline{X}$ for all studied traits under SDF and SDH conditions two seasons.

Item		SDF			SDH			(D / I %)
		S_1	S_2	Average	S_1	S_2	Average	
1- NFL	Min.	61.0	63.33	62.16	52.66	54.66	53.66	13.68
	Max.	80	79	79.5	70	69	69.5	12.57
	$\overline{X}$	71.73	71.55	71.64	62.01	61.71	61.86	13.65
2- NF	Min.	26.00	26.66	26.33	16	16.33	16.165	38.61
	Max.	44.00	44.66	44.33	34	34.66	34.33	22.55
	$\overline{X}$	35.26	35.37	35.13	25.46	25.55	25.50	27.41
3- FS	Min.	41.05	36.95	39.0	29.27	27.49	28.38	27.23
	Max.	61.68	62.12	61.9	53.92	53.84	53.88	12.92
	$\overline{X}$	49.21	49.55	49.38	41.06	41.38	41.22	16.52
4- WF	Min.	65	66.33	65.66	56.00	57.33	56.66	13.70
	Max.	130	131.33	130.66	115.00	115.00	115.00	11.98
	$\overline{X}$	101.19	101.35	101.27	78.44	88.57	83.50	17.54
5- YP	Min.	1008.33	1008.33	1008.33	590.0	650.0	620	38.51
	Max.	2200.00	2260.00	2230.00	1440.0	1470.0	1455	34.97
	$\overline{X}$	1581.99	1599.66	1590.82	984.66	900.82	942.74	40.73

S_1 = first season S_2 = second season

Table 7: Decrease or increase % (D / I %) every genotypes under SDF compare to SDH conditions for all studied traits.

Characters genotypes	NFL			NF			FS		
	SDF over two season	SDH over two season	(D / I %)	SDH over two season	SDH over two season	(D / I %)	SDH over two season	SDH over two season	(D / I %)
1	75.66	68.49	9.0	32.16	27.16	15.50	42.49	39.65	6.6
2	69.50	59.50	14.0	28.83	20.66	28.3	41.47	34.72	16.2
3	79.50	69.50	12.0	44.33	34.33	22.5	55.75	49.39	11.4
4	67.83	61.33	9.5	41.00	30.83	24.80	61.13	50.39	17.5
5	71.66	60.66	15.3	38.99	27.66	29.0	54.41	45.49	16.3
6	65.50	55.66	15.0	40.50	29.99	25.90	61.90	53.88	12.9
7	68.33	59.00	13.6	37.16	26.33	29.10	54.38	44.61	17.9
8	75.16	63.33	15.7	40.50	27.49	32.10	53.91	43.39	19.5
9	79.50	68.66	13.6	41.33	31.16	24.60	51.98	45.37	12.7
10	68.66	56.99	16.90	35.66	26.83	24.70	51.93	47.07	9.3
11	75.50	64.99	13.90	31.50	23.83	24.30	41.72	36.66	12.10
12	63.83	55.16	13.50	26.33	16.16	38.6	41.24	29.30	28.9
13	70.50	60.66	13.9	29.66	21.00	29.10	42.06	34.61	17.7
14	69.00	59.66	13.5	32.16	20.16	37.3	47.10	34.10	27.6
15	74.33	64.33	13.4	29.16	18.83	35.4	39.30	29.33	25.3
Average	**71.64**	**61.86**	**13.6**	**35.31**	**25.50**	**27.70**	**49.38**	**41.22**	**20.70**

Table 7: Con.

Cha. Geno.	WF			YP		
	SDH over two season	SDH over two season	(D / I %)	SDH over two season	SDH over two season	(D / I %)
1	81.49	76.49	6.10	1247.33	830.0	33.00
2	87.50	75.83	13.30	1110.00	595.0	46.00
3	130.66	115.00	11.90	2230.00	1455	34.00
4	115.33	97.83	15.10	2060.00	1373.33	33.00
5	113.99	96.16	15.60	17.56.66	1076.66	38.00
6	116.33	104.83	9.80	2114.99	1366.66	35.00
7	107.33	93.50	12.80	1661.66	1019.83	38.00
8	110.66	95.66	13.50	1831.50	1133.33	38.00
9	113.33	99.33	12.30	1938.33	1211.66	39.00
10	79.66	69.66	12.50	1295.83	783.33	39.00
11	76.83	67.99	11.50	1139.99	683.33	40.00
12	104.5	87.49	16.20	1541.66	961.66	37.00
13	110.99	96.99	12.60	1491.66	909.83	39.00
14	65.66	56.66	13.70	1006.66	651.66	35.00
15	104.83	94.33	10.00	1430.00	771.66	46.00
Average	**101.27**	**83.50**	**17.50**	**1590.82**	**988.19**	**37.00**

Table 8: Genetic Parameters for all studied traits in two seasons.

Seasons Characters	Season 1st						Season 2nd					
	$\sigma^2 g$		$\sigma^2 p$		H^2		$\sigma^2 g$		$\sigma^2 p$		H^2	
	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH	SDF	SDH
1- NFL	31.25	27.80	31.91	28.43	97.98	97.76	23.34	21.83	26.50	24.34	88.11	89.67
2- NF	33.37	28.57	33.85	28.97	98.59	98.64	31.01	23.68	33.84	26.03	91.61	90.98
3- FS	60.46	59.65	62.10	60.99	97.35	97.80	6.15	53.17	13.15	60.82	88.79	87.43
4- WF	337.56	244.13	338.77	244.84	99.64	99.71	339.93	256.51	345.40	258.92	98.41	99.07
5- YP	154058.33	75685.77	154516.93	75876.48	99.70	99.74	149567.06	77782.54	150797.06	78491.11	99.18	99.09

Table 9: Correlation coefficient between YP and NFP, NF, FS, WF traits under SDF (Upper) and SDH (lower) conditions.

Characters	NFL	NF	FS	WF	YP
NFL	×				
NF	-0.066 -0.036	×			
FS	0.548** 0.440**	0.307** 0.387**	×		
WF	-0.571** -0.461**	-0.148 0.022	0.893** 0.910**	×	
YP	0.905** 0.84**	-0.026 -0.046	0.759** 0.712**	0.783** 0.729**	×

Conclusion:

In this study, possible to determine the four genotypes (No. 3, 4, 9 and 10) of high yield, more stable and suitable for sowing under heat stress and favorable conditions in upper Egypt.

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