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A study on adaptation of tomato ecotypes in northern latitudes under southern Iran conditions

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Abstract

Tomato hybrids and cultivars from northern latitudes are tolerant to temperature variations and are early maturing crops. In order to produce new cultivars for southwest of Iran, it is necessary and useful to study adaptation of genotypes in this area. The seeds of 74 cultivars from Moscow and 8 hybrids from Netherlands were germinated and then transplanted to Jiffy-pots under plastic tunnels before being transferred to the soil in the field. Growth habits, leaf and inflorescence forms, fruit weight, fruit number, yield in each harvest, total yield and earliness were recorded. There were differences among cultivars for all measured characteristics. Some cultivars had relatively good tolerance to high temperature, and could produce fruits at temperatures higher than 30°C. The tested varieties had different growth habits. Maximum yield was obtained from determinate types, M66, M63, M49 and M48. For most cultivars, the largest fruits were produced in the first harvest while the next harvests had smaller fruits. A negative correlation was observed for fruit numbers and average fruit weight. Also, some cultivars including M39, M46, M74, M40, and M35 exhibited early and more uniform yield per plant compared with control varieties. Some cultivars such as M48 and M66 had late maturity with higher yield as compared with control. The tested entries were classified on the basis of leaf shape, inflorescence, fruit number and weight. Maximum difference was between controls and M27.

Key words: Ecology, temperature stress, growth habit, tomato

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Introduction

Tomato (*Lycopersicon esculentum* Mill) originated from And Mountains at North American coasts and domesticated in Mexico and northern America. High ability of this plant in adaptation to various climatic conditions helped this crop to be cultivated from equator line to North Pole (Atherton and Rudich, 1986).

According to several researches, temperature is one of the important factors affecting physiological reaction of tomato (Nakano, 2004). In the original climate of this plant, temperature changes between minimum of 15˚C at night and maximum of 19˚C at day time (Atherton and Rudich, 1986). Nautiyal *et al.* (2005) indicated that optimum temperature for growth and development of tomato is 26/20˚C during day and night. Some other studies indicate that desirable growth of this plant is obtained between a minimum of 15˚C and a maximum of 30-35˚C (Tarakanov and Mukhin, 1993). Some researchers reported that suitable minimum temperature in transplanting time is 17-19˚C in day and 10-12˚C at night. When temperature increases over 30˚C, pollen grains are destructed (Tarakanov and Mukhin, 1993) and reduction in fruit yield is observed (Sato and Peet, 2005). There are more than 6000 tomato cultivars over the world and every one has its own physiological and morphological characteristics. These cultivars show different reactions for temperature, light, and maturation time (Breshnov, 1952; Tarakanov, 1975).

High temperature has been a limiting factor for tomato fruit formation; and many efforts have been made to find appropriate cultivars for tropical areas (Sott *et al.,* 1995). South of Iran has been known as one of the important centers of vegetable production in the country, but its high temperature always has been a limiting factor for fruit formation of many vegetable crops in this region, especially that temperature rises rapidly, and prevents fruits formation, growth and development.

During last 25 years, tomato production in Iran has increased from 130 to 2975 thousand tons per year (Anonymous, 1977 and Anonymous, 1997). In order to increase the quantity and quality of tomato yield, it is necessary to produce improved cultivars, for each ecological region.

This study was conducted to study the adaptability and desirable characteristics of tomato ecotypes from northern latitudes, compared with existing cultivars in Iran, and introduce them for use in future to produce improved tomato cultivars.

Materials and methods

Eighty two tested genotypes were coded as follows: Samples which were from Academy of Agriculture Moscow, were coded with letter 'M' and a number from 1 to 74. Samples from Netherlands, *i.e.* 'Rs2661', 'Arfela', 'Parana', 'Royesta', and 'Dual Prido' (obtained from Royal Sluis Company) were coded as H5, H7, H8, H2, and H1, respectively. Samples from United States *i.e.* 'Florida', 'President' and 'Floramerica' were signed as H6, H4 and H3, respectively. The seeds were treated with Vitavax 75% fungicide against pathogens, and then 20 seeds of each genotype were germinated on wet filter paper in Petri dish at 24-26 °C on January 20th, 2000. 'Early Urbana' and 'Red Cloud' cultivars were used as controls. After radicle appearance, two germinated seeds were sown in Jiffy-pots and then irrigated. Jiffy-pots were filled with equal portions of sand, manure, and soil. In warm hours of the day, plastic tunnels were removed to bring about the field weather conditions for plants. By the end of the day, plants were covered again. Jiffy-pots kept under plastic

tunnels until open air condition was suitable for transplantation. On March 15, ten vigorous seedlings from every cultivar were planted to the field. Row spacing and plant spacing in rows were 110 and 35 cm, respectively. Maximum, minimum and daily average temperatures were recorded under plastic and open air. In order to adapt the seedlings to outdoor conditions, plastic covers were removed from plants three days before transplantation. Since May 22, five vigorous plants from each cultivar were selected for harvest. Selected plants were harvested five times with one week interval. Except for final harvest, fruits had turned red at harvest time. From each cultivar, at least five plants were studied for plant height, growth and developmental processes, inflorescence form, fruit maturity time, fruit number per each harvest, total fruit number per plant, total weight of fruit per plant, and average of fruit weight. Also, maximum and minimum of these characters were calculated for all genotypes. Continuous data were reported as means ± standard deviation (SD). The growth habit trends and correlation coefficients of studied characters were drawn and calculated by software STATISTICA, V.5.1. The studied cultivars were classified for growth habit, inflorescence form, leaf shape, harvested fruits number, and average fruit weight by Complete Linkage Method based on Euclidean distance (Johnson and Wichern, 1998). All variables had the same weight and the following formula was used:

$$d_{(x,y)} = \sqrt{(x_1-y_1)^2+(x_2-y_2)^2+\ldots\ldots+(x_n-y_n)^2}$$

Results

Temperature changes: Premature changes under and around plastic tunnels, and in the field are presented in Figs. 1 and 2. In first 30 growing days of seedlings under plastic tunnels, the average of maximum temperature was 31˚C, minimum temperature 10˚C, and the average daily temperature was 20˚C. The satisfactory growth conditions of some genotypes indicated that it is possible to keep tomato seedlings after germination in the field without heating sources. Emergence of the germinated seeds can take place, only by using plastic cover during winter without heating sources in Ahwaz region. 25 days after transferring the seedlings to the field; the average temperature was 19˚C which was suitable for growth and development of seedling. This temperature was suitable for growth and development of plants until 30 days after they were transferred. But after 62 days, the average temperature raised up to 30˚C. Maximum temperature in first 25 days raised rapidly, so that at the end of harvesting period it was over 40˚C. This high temperature caused the branches and leaves in many cultivars to dry out. Minimum temperature did not decrease below 10 ˚C. So, at harvest period, plants were not exposed to cold weather; instead, after two months, plants steadily exposed to warm weather (over 30˚C). Majority of cultivars showed very good resistance to temperature changes until their growth stages were finished. High fruit yields of some late maturing cultivars can confirm their relative resistance to hot temperatures. Generally, it can be concluded that climatic conditions of Ahwaz from sowing date of seeds (March 3) to harvesting the fruits (June 15) is suitable for tomato cultivation in this region.

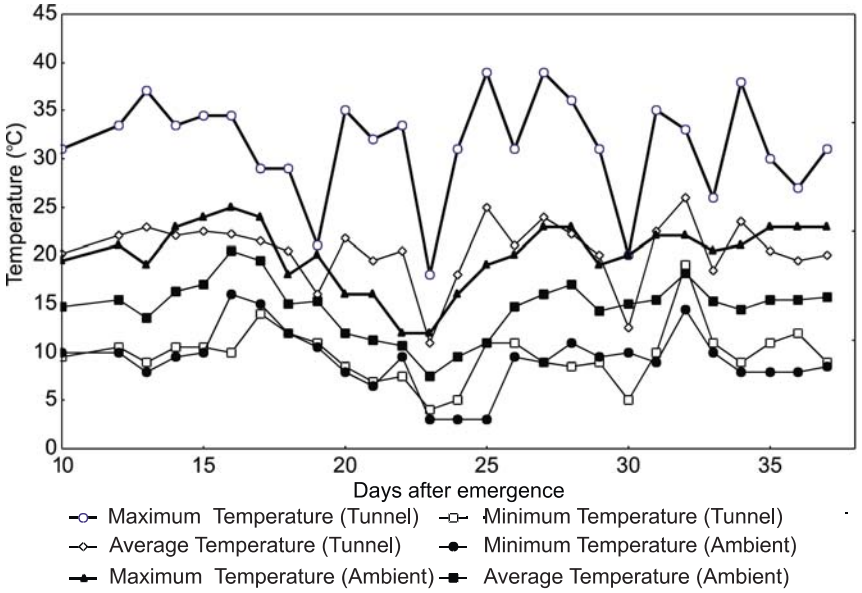

Fig. 1. Temperature variations under plastic tunnel and in open air.

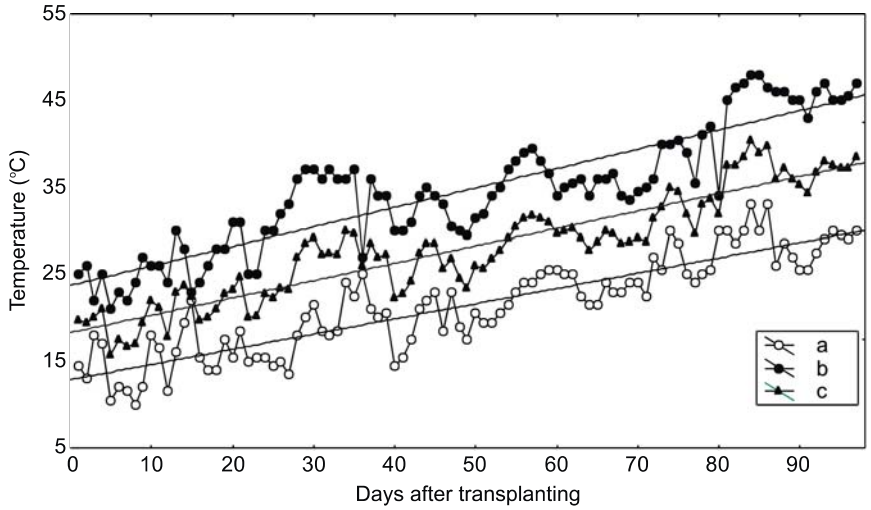

Fig. 2. Temperature variations in open air after transferring seedlings to the field
a= maximum. b= minimum. c= average

Growth habit: The growth habit of tomato cultivars can be determined by their continuous sympodium production (Rubatsky and Yamaguchi,1997). Tomato accessions were divided into three groups (Table 1). First group included cultivars with determinate growth habit, which in turn, by considering their main stem and axillary branches, they were divided to two subgroups. First subgroup had very short main stems; their main stem growth stops after appearance of 2nd to 4th flower cluster. Some of these cultivars were very early maturing than controls, and in some entries, axillary branches did not grow. These cultivars are suitable for mechanical harvest. They have small canopy, can be cultivated with high density, resulting higher productivity. Second subgroup of cultivars had determinate growth habit, but main stem had more growth, axillary branches grew and occupied more space in the field. This subgroup is not suitable for mechanical harvest, because they have low uniformity in maturation time. In these cultivars, some of axillary branches

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Table 1. Classification of tomato cultivars according to their growth habit

Growth habit	Cultivars
First group	M18, M33, M34, M35, M36, M37, M38, M39, M40,M41, M42, M43, M46, M50, M52, M54, M57, M58, M60, M61, M62, M69, M70, M73, M74
Second group	M3, M4, M5, M6, M7, M23, M24, M25, M27, M30, M31, M32, M44, M47, M48, M49, M55, M56, M59, M63, M64, M65, M66, M72, M77, H1, H4, H7, M17, M19, Red Cloud, Early Urbana
Third group	M2,M8, M9, M22, M28, M20, M45, M67, M68, M78, H9, M10, M1, M12, M13, M14, M15, M21, M26, M29, M71, H2, H5, M16

have high fruit productivity. Cultivars of second and third groups have semi determinate and indeterminate growth habits. They are suitable for greenhouse cultivation.

Fruit weight and number: Studied ecotypes were classified according to their fruit weight. Fruits less than 40 g, were classified as very small, those between 40-69.9 g as small, fruits between 70-100 g as medium, and those that weighted more than 100 g as large fruits (Table 2). Tomato plant has two main yield components, number of fruits per plant and average fruit weight (Wein, 1997). The correlation between number of fruits per plant and average fruit weight is presented in Fig. 3. There was a negative correlation between number of fruits per plant and average fruit weight so that by increasing total number of fruits, average fruit weight was decreased. Correlation coefficient (R) was significant at 5% level in all cases (Ravinder and Cheema, 2004). Very wide range of genotypes was included in tested cultivars with different growth habits and fruit size which is presented in Tables 3 and 4 (Singh *et al.,* 2004).

In most cases, large fruits were obtained in first harvest of every cultivar, and smaller fruits in next harvests. But generally, number of fruits in first harvest was low although it was increased in next harvests. In the other word, there were negative and significant correlations between fruit number and average fruit weight, except for cultivars having average fruit weight less than10 g. By using Fig. 3, the yield potential of plants can be estimated.

These results confirm that many of tested cultivars have better potential to produce more fruit numbers, compared to standard cultivars.

Inflorescence: The morphology of tomato inflorescence is affected by genotype and also by environmental conditions (Seleciar, 1987). The division of main axis of inflorescence depends on plant genotype and environment. Usually, the first is produced from beneath the flower, axillary branch. Tomato inflorescences can be classified according to the number of flowering axes. Simple inflorescences have only one axis, therefore have limited number of flowers. Semi compound inflorescences have two or more axes. Sometimes, these inflorescences have more than 300 flowers. The studied cultivars in first year of experiment are presented according to this classification (Table 5).

Leaf shape: The size and shape of leaves were different in various tomato cultivars. Tomato plants generally have serrate leaves, but

Table 2. Classification of tomato cultivars according to their growth habits and fruit weight

Fruit weight	Growth habit		
	Determinate	Semi-determinate	Indeterminate
Large (>100 g)	H4, M32, M72, M47, Red Cloud, Early Urbana, H1, D4, F6, E5, H7	M22, M68,	M21, H2, H5
Medium (70-99 g)	M52, M56, H8, M63, M65, M42, M23, M3, M30, M73, M48, M64	M8, M9, D5, M11	
Small (40-69.9 g)	M36, M57, M25, M41, M37, M50, M7, M38, M14, M46, M5, M6, M18, M56, M17, M19 M36, M69, M62, M40, M34, M49, M13, M1	M2, M28, M67, M78, H9, M10, M14, M15, M12, M13	M26
Very small(<40 g)	M54, M58, M61, M39, M71, M74, M24, M35, M43, M31, M33, M27	M20	M71, M16, M29

Table 3. The minimum and maximum total fruit number per plant of various cultivars in different growth habit types and it's average in control cultivars

Harvest date after transplanting (days)	Growth habit						Control cultivar	
	Determinate		Semi- determinate		Indeterminate			
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Red Cloud	Early Urbana
117	0	10±2*	0	4±2	0	6±1	1±0	2±1
125	0	27±9	0	5±2	0	9±3	2±1	2±1
132	0	43±13	2±1	18±4	2±1	38±18	3±2	3±2
139	0	38±10	0	36±9	0	53±21	5±1	3±2
146	0	258±64	5±2	56±10	9±1	55±21	12±7	15±5
Total	6±3	332±80	11±6	76±40	17±5	163±35	23±8	26±11

* mean ± SD.

Table 4. The minimum and maximum fruit weight (g) per plant of various cultivars in different growth habit types and it's average in control cultivars

Harvest date after transplanting (days)	Growth habit						Control cultivar	
	Determinate		Semi- determinate		Indeterminate			
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Red Cloud	Early Urbana
117	2±1*	310±120	55±32	143±38	15±8	141±40	141±40	123±45
125	2±1	178±34	44±11	108±31	6±4	154±30	140±28	152±10
132	4±1	204±50	48±4	117±33	9±1	159±40	117±50	132±56
139	9±1	147±32	29±4	90±26	7±1	133±3	105±17	143±40
146	2±1	172±49	27±5	100±18	6±1	113±18	88±36	83±23
Total	3±1	146±35	21±6	168±40	6±3	128±33	102±20	103±25

* mean ± SD.

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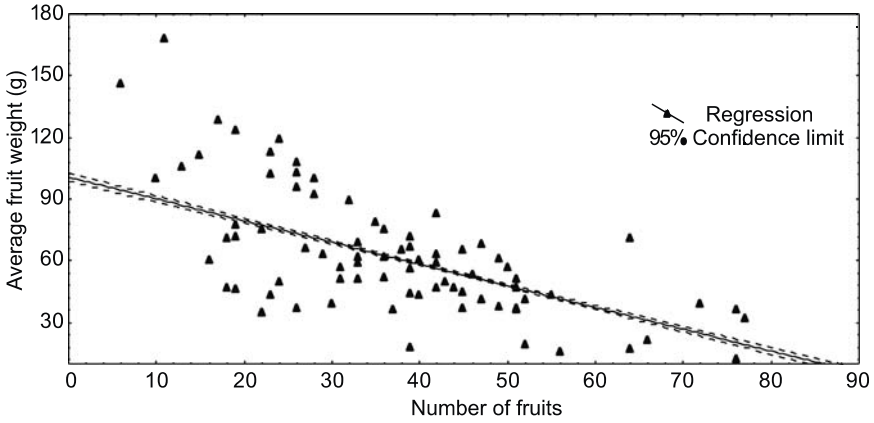

Fig. 3. Correlation between average fruit weight and number of fruits per plant

"*Grand Folium*" cultivars because of a recessive gene have leaves similar to potato plants. Tomato leaf was classified into 3 groups according to their shape as given below (Table 6).

Potato leaf shape: Leaf shape in this group was similar to potato leaves; sometimes, leaves are similar to pepper leaves.

Normal tomato leaves: In this group, leaves were similar to normal tomato leaves which are serrate types. Majority of studied cultivars were included in this group.

Carrot leaf shape: In this group leaves had maximum depth and they were similar to carrot leaves.

Fruit yield: The average fruit yield was different among studied entries, for each harvest and for total yield per plant (Table 7).

First harvest (117 days after transplanting): In early maturing cultivars, the first harvest had very wide range of fruit yield. The average yield per plant of some cultivars such as M9, M39, M74 and M73 were more than standard controls. Although some of these cultivars had good yield in this harvest, but their total yields were below controls. Maximum yield of first harvest was obtained from M39 which is an early maturing cultivar. Maximum number of fruits at first harvest per plant was related to M74 cultivar with average weight of one fruit as 42 g.

Second harvest (125 days after transplanting): In this harvest, like first harvest, cultivars had a wide range of yield with a 400 g difference between maximum and minimum yielding cultivars (Table 7). H1 cultivar did not differ significantly from Early Urbana (control). Some other cultivars including H5, H4, and M39 had fruit yield more than control. Comparing two control varieties, for second harvest, Early Urbana was earlier than Red Cloud, although they did not show any significant difference for total fruit yield per plant. Some of tested cultivars as compared with controls were earlier and had yielded more uniformly than controls. Some cultivars which had a good growing activity at the end of the season, were later maturing types compared with controls. M32, M31, M42, M23, M21, M22, H8, M55, M49 and M48 were included in this

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Table 5. Classification of tomato cultivars according to their growth habit and inflorescence type

Inflorescence type	Growth habit		
	Determinate	Semi determinate	Indeterminate
Simple	H7, M1,M17, M18, M19, M23, M24, M25, M3, M30, M31, M32, M36, M37, M38, M4, M44,M45, M46, M47, M48, M49, M5, M52, M54, M67, M55, M59, M6, M60, M63, M64, M65, M66, M67, M68, M69, M7, M70, M72, M73, M74, M77, M78, Red Cluod, Early Urbana	M10, M1, M13, M14, M15, M2, M8, M28, M20, M45, M67, M68, M78	H2, H5, M21, M26, M29, M71
Semi-composite	H4, M33, M34, M35, M57, M58, M61, M62		
Composite	H1,M27, M39, M40, M41, M42, M43, M50, M56		M16

Table 6. Classification of tomato cultivars according to their growth habits and leaf shape

Leaf shape	Growth habit		
	Determinate	Semi-determinate	Indeterminate
Potato type	H1, M18, M78, M46, M57, M60, M62 M68, M65	M68, M78	
Common type	H4, H7, M17, M19, M23, M24, M25, M27, M3, M30, M31, M32, M35, M36, M37, M38, M39, M4, M40, M41, M42, M47. M48, M49, M5, M50, M52, M55, M56, M58, M59, M6, M61, M63, M7, M70, M71, M72, M73, M74, M76, Red Cloud, Early Urbana	H9, M11, M2, M8, M22, M28, M45, M67, M10, M1, M13, M14, M15	H2, H5, M16, M21, M26, M29, M71
Carrot type	M33, M43, M45,M44, M64		

Table 7. Total fruit weight (g) per plant of various cultivars in different growth habit types and it's average in control cultivars

Harvest date after transplanting (days)	Growth habit						Control cultivar	
	Determinate		Semi- determinate		Indeterminate			
	Minimum	Maxium	Minimum	Maxium	Minimum	Maxium	Red Cloud	Early Urbana
117	0	411±71*	0	386±200	0	141±30	152±40	262±80
125	0	417±130	0	316±103	0	385±146	350±44	363±220
132	0	1114±374	194±68	1205±380	75±42	533±150	340±180	359±150
139	80±40	2754±700	0	1046±250	0	901±560	508±120	430±150
146	0	2415±700	319±200	2250±650	585±255	1443±230	1009±700	1257±711
total	706±80	4535±800	1724±120	2911±655	871±194	2985±300	2350±800	2671±825

*- Plus and minus values are mean ± SD.

group. Maximum numbers of mature fruits were obtained from M33 and M27.

Third harvest (132 days after transplanting): Majority of cultivars could produce some fruits in this harvest. Fruits of early, some moderate, and late maturing cultivars were harvested for third time. The early maturing cultivars (such as M39) had lower yield in this harvest as compared with previous harvests. Late maturing cultivars (such as M48) when compared with fourth harvest had very low yield; but some of intermediate maturing cultivars (such as M73) had relatively good yield. In this stage both control varieties could produce some fruit. The yields of early maturing cultivars were reduced at this stage. Many cultivars had more yield per plant in this harvest, as compared with controls. These cultivars were M65, M29, H2, M30, M47, M66, M34, M54, M40, M12, M1, M37, M42, M14, M48, M49, M53, H5, M19, M8, M15, M32, M73, M51, M6, M52, M25 and M69.

Fourth harvest (139 days after transplanting): The amount of fruit yield in this stage was very variable between cultivars. Some cultivars that had relatively good yield in first harvest had minimum yield in this harvest. Cultivars such as M48 that produced reasonable fruit yield in third harvest, produced even more fruits in this stage. Maximum yield in this harvest was obtained from this cultivar. In this harvest, many cultivars produced more yields than controls. These cultivars were M49, M53, H5, H8, M55, M8, M35, M7, M78, M5, H4 and M41. The maximum yield in this stage was produced by cultivar M16.

Fifth harvest (146 days after transplanting): At this stage, all of red and green fruits from each plant were harvested at the same time. Maximum fruit yield was obtained from M66, which is a late maturing cultivar. Early maturing cultivars had minimum yield. Medium and late maturating cultivars had good production; and it seems that under suitable environmental conditions, one or two additional harvests from late maturing cultivars could be obtained. In this harvest, several cultivars produced more fruit yield than controls. They included M10, M22, H8, M5, M18, H19, M1, H7, M48, M52, M2, M9 and M3. Average yield per plant in Red Cloud was lower than Early Urbana, and in ranking entries, a number of cultivars were placed between them. Although, statistically there was not any significant differences between these controls.

Total yield: The amount of total yield in many cultivars, M48, M66, M49, M63, M8, M16, H5, H8, M65, H1, M22, M19, M15 and M73 was more than standard controls. Total yield of some cultivars such as M25, M3, M17, M9, H9, M54, M64, H7, M5, M47, M3, M78 and M7 were lower then Early Urbana and more than Red Cloud. The differences between yield per plant were very significant. Maximum fruit yield per plant was 4.53 kg and minimum 0.70 kg. The average fruit yield per plant for Early Urbana and Red Cloud were 2.67 and 2.35 kg, respectively. In cold area, tomato axillary branches are pruned in order to reserve more nutrition for fruits. But in warmer regions, in order to prevent fruits from sun radiations, these branches are not pruned. Usually, axillary's branches do not produce fruits or they have very limited fruit yield, in some of studied cultivars, axillary branches produced more yields than standard controls. This leads to increase the total yield per plant. This is a good sign of the presence of a high tolerance in some cultivars. However, if these fruits are not prevented from high solar radiation, the probability of sunburn will be increased.

Classification of cultivars: In order to have better evaluation and comparison between tested cultivars, they were classified by Euclidian method. As it can be seen it Fig. 4, minimum distance was between M3 and M64 entries. Maximum distance was between cultivars with high fruit numbers but with less weight *i.e.* cherry types and some other types. So that these distances between

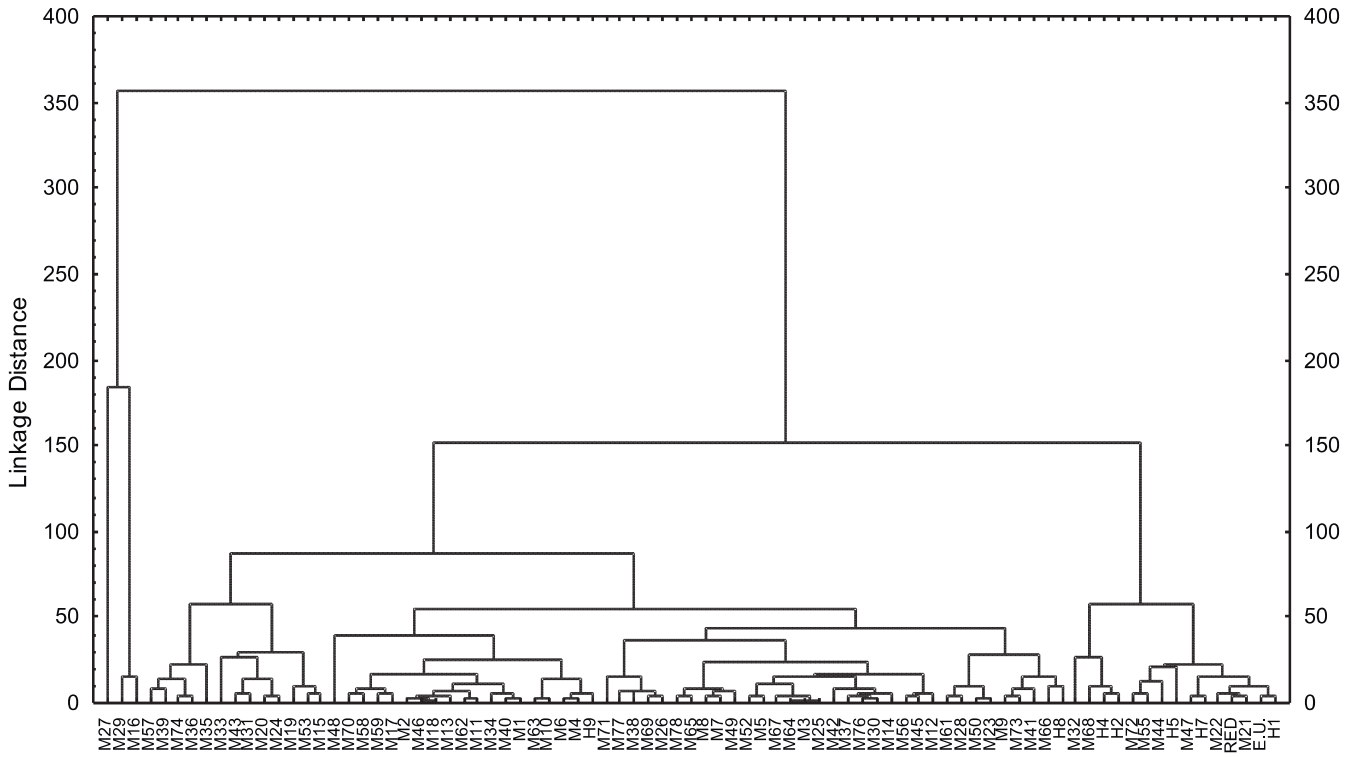

Fig. 4. Classification of tomato cultivars based on their growth habit, inflorescence type, leaf shape, number of fruits, and average fruit weight using Euclidian method

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M27 and controls were 324 and 325 Euclidean units. For better understanding of this classification, 83 cultivars were divided into 7 groups. Minimum equal distance for group formation was 55 Euclidean distances (Nafar, 1985).

First group: This group had only M27 cultivar, which had semi determinate growth type with an average fruit weight of 2.6 g and 332 fruits per plant. So, it had maximum fruit number with minimum fruit weight.

Second group: In this group, only 2 cultivars, *i.e.* M29 and M16 were included. These were similar to previous group, with a difference that fruit weight increased but fruit numbers per plant decreased. The average fruit weight in this group was 7.85 g, with an average of 155.5 fruits per plant.

Third group: This group included M35, M63, M74, M39 and M57 which had super determinate type. Their average fruit weight was 32.74 g, and fruit numbers was 31 fruits per plant.

Fourth group: Cultivars, M15, M53, M19, M24, M20,M31, M43, M33, M58, M70, M48, M4, M6,M10, M63, M1, M40, M43, M11, M62, M13, M18, M46, M2, M17, M59, M64, M67, H9, M5, M52, M49, M7, M8, M65, M78, M26, M69, M38, M77, M71, M12, M45, M56, M14, M30, M76, M37, M42, M25 and M3 were included in this group. These cultivars had different growth habits but they had similar inflorescences. Their fruit weight was 49 g and they had 48.9 fruits per plant in average.

Fifth group: This group included H8, M66, M41, M73, M9, M23, M50, M28 and M61 cultivars. Average of their fruit weight was 75.6 g and they had 28.6 fruits per plant.

Sixth group: In this group, cultivars H2, H4, M68 and M32 were included. Average of their fruit weight was 131.7 g and they had 13.2 fruits per plant.

Seventh group: This group included M22, H7, M47, H5, M44, M55, M72, Red Cloud and Early Urbana cultivars. Their average fruit weight was 102.73 g and they had 22.1 fruits per plant in average.

Discussion

In this classification, more cultivars were included in the middle classes. By getting nearer to the end classes, the number of cultivars reduced, so that, the first class had only one cultivar and the last class had only 9 cultivars. The fruit weight of first class was low, the middle class had medium fruit weight and the last class had heavy fruit weight, respectively. But cultivars that placed in middle classes had higher yields, large fruits, and lower fruit numbers. This classification helps us to better recognition of distances between cultivars. If it is needed to select desirable cultivars with good characters, cultivars that are nearer to controls should be selected for quality improvement. Cultivars with large Euclidean distances can be used in breeding programs to make great changes in various characterizations of fruits, leaves, growth habit, inflorescence, and their adaptation to various conditions (Nuez *et al.*, 2004)

Different environmental stresses cause reduction in crop yield, so that in most cases, the plants under field stress can express only 10-20 percent of their real yielding potentials (Ghorbani and Ladan, 2005).

The first step to confront against temperature stress is using tolerant varieties which have been adapted to different climatic conditions (Giordano, 2005; Matsubara and Tanaka, 2005). Generally, tomato varieties from cold climates (which show relatively, good tolerance to low temperatures) are early maturing varieties (Ansari *et al.*, 2003). In south areas of Iran, like similar climates of the world, for spring cultivation, usually plastic tunnels for covering plants, cultivation in sandy soil, and greenhouse cultivation are used (Kurklu and Bilgin, 2002; Salokhe, 2005). But some times unexpected cold weather after removing plastic tunnels can cause real damages in plants which have been grown under tunnels. This results a severe reduction in fruit yield. Furthermore, because in these areas by starting April, the weather temperature increases significantly which causes in reduction of pollen grain population and bud retention, and finally severe reduction in fruit yield (Sato and Peet, 2005). Also, the leaves will get burned and carbohydrate production will be diminished. The observed differences between varieties in reaction to this stress because of their susceptibility levels to rapid variations of temperature (Sato and Peet, 2005).

There are great deals of variations between different tomato cultivars, especially those which grow in northern latitudes. These variations are morphological characters such as leaf and fruit shape, inflorescence type, fruit size, stem and leaf length, and fruit yield. Variations in physiological characters include maturity time, tolerance to temperature variation and fertility rates in hot conditions. By using this genetic variability, better tomato varieties can be developed.

In general, it can be said that some of tested cultivars have good characters, such as adaptability to environmental conditions, tolerance to a wide range of temperature (especially in reproductive stage), early maturity, and maturation uniformity of yield. But for some other suitable characters such as disease resistance, salinity tolerance and good storage capability, they are to be evaluated for additional characterstics. Thus, in the first stage, it is better to develop pure lines (Nautiyal, 2005), then to make crosses between cultivars that have different suitable characters to produce suitable cultivars for each region. Therefore, in this stage of breeding program, entries M48, M21, M55, M66, M8, M40, and H1 were selected, then, in order to produce next generation, seeds were collected from plants of these selected lines which produced maximum yield.

The study revealed that several evaluated cultivars had good tolerance to high temperatures, especially in fertilization and fruit formation stages. Some studied cultivars had a wide range of yielding potentials. In most cases, with increase in fruit numbers of cultivars, their average fruit weights were reduced. Classification of cultivars indicated that some cultivars with good fruit productivity are near standard controls by means of Euclidean distance method. Therefore, considering the measured characters, it is possible to select cultivars for hybridization and producing new lines and hybrids. In the present study, entries M48 and M64 showed a good tolerance to temperature changes in Ahwaz area and a desirable fruit yield, even more than other varieties. Therefore, these can replace local standard varieties.

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References

Anonymous, 1977. *National Statistical Yearbook of Iran*. Statistical Center of Iran, Tehnan, Iran, (in Farsi).

Anonymous, 1997. *National Statistical Yearbook of Iran*. Statistical Center of Iran, Tehran, Iran (in Farsi).

Ansari, N.A., R. Mamghani and M. Ghasemi, 2003. The tolerance of some tomato ecotypes of northern latitudes to winter hardiness at Khuzestan province, Iran. *The Scienctific Journal of Agricultre,* Shahid Chamran University, Ahwaz, Iran, 26: 127-136.

Atherton, J.G. and J. Rudich, 1986. *The Tomato Crop*. Chapman and Hall, New York, NY, 635 p.

Breshnov, D.D. 1952. *New Cultivator for Greenhouse*. Destijenia, Nauki Selekokhoziastvennomu, Liningarad, gazeitno-vrhalnoe and kinoe. 200p.

Ghorbani H. and Ladan A. Moghaddam, 2005. *Introduction to oxidative stress and plant strains*. Davavin Publication Instute, 128 p.

Giordano, L.de.B., L.S. Boiteux, J.B.C. Silva and O.A. Carrijo, 2005. Selection of heat tolerant tomato inbred lines from landraces adapted for cultivation in the north region of Brazil. *Horticultura Brasileira,* 23(1): 105-107.

Johnson, R.A. and D.W. Wichern, 1998. *Applied Multivariate Statistical Analysis.* Prentice-Hall, Inc. New Jersey, pp. 744-748.

Kurklu, A. and S. Bilgin, 2002. The effects of rock-bed solar energy storage system on the air temperature and plant growth in a plastic tunnel type greenhouse. Proceedings 8th International Congress on Mechanization and Energy in Agriculture, Kusadas, Turkey, 15-17 October 2002; 221-226.

Matsubara, Y. and N. Tanaka, 2005. Cultivar difference in growth of tomato rootstocks under low temperature stress. *Envir. Control Bio.,* 43(2): 139 -142.

Nafar, M. 1985. *Statistics and probability*. Jahad Daneshgahi Publications, Tehran, Iran, pp.50-70, (in Farsi).

Nakano, Y. 2004. Response of tomato root systems to environmental stress under soilless culture systems. *Bull. Nat. Inst. . Veg. .Tea Sci.,* 3: 57-107.

Nautiyal, P.C., M. Shono and Y. Egawa, 2005. Enhanced thermotolerance of the vegetative part of MT-sHSP transgenic tomato line. *Scientia-Hort*., 105(3): 393-409

Nuez, F., J. Prohens and J.M. Blanca, 2004. Relationships, origin, and diversity of Galapagos tomatoes: implications for the conservation of natural populations. *Amer. J. Bot.*, 91(1): 86-99.

Ravinder, K. and D.S. Cheema, 2004. Inter relationship studies for quality attributes with yield and its components in tomato (*Lycopersicon esculentum* Mill). *J. Res. Punjab Agri. Univ.,* 41(2): 223-226.

Rubatsky, V.E. and M. Yamaguchi, 1997. *World Vegetables Principles, Production and Nutritive Values.* 2nd ed. Chapman & Hall, New York, NY, 415p.

Salokhe, V.M., P. Soni and H.J. Tantau, 2005. Effect of net size on horizontal temperature gradients in naturally-ventilated tropical greenhouses. *J. Food, Agric. Envir.*, 3(2): 316-322.

Sato, S. and M.M. Peet, 2005. Effects of moderately elevated temperature stress on the timing of pollen release and its germination in tomato (*Lycopersicon esculentum* Mill.). *J. Hort. Sci. Biotech.,* 80(1): 23-28.

Singh, J.K., J.P. Singh, S.K Jain and J. Aradhana, 2004. Correlation and path coefficient analysis in tomato. *Progressive Hort.,* 36(1): 82-86.

Sott, J.W., S.M. Olson, T.K. Howe, P.J. Stoffela, J.A. Bartz and H.H. Bryan, 1995. Equinox, heat tolerant hybrid tomato. *HortScience*, 30(3): 647-648.

Tarakanov, G.U. and B.A. Mukhin, 1993. *Olericulture.* Moscow, Kolos, p. 512 (in Russian).

Tarakanov, G.U. 1975. *New in olericulture*. Moscow, Eznanie, 175 p. (in Russian).

Wein, H. C. 1997. *The Physiology of Vegetable Crops*. CAB international, NY. 10016-4341, 661 p.

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