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Evaluation of Six Tomato (*Solanum lycopersicum* Mill.) Hybrids Under Cooled Plastic Tunnel Conditions in the Sudan

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Abstract

The experiment was conducted during the summer seasons of the three years; 2012, 2013 and 2014 (April to August) consecutively at Shambat Research Station, under cool plastic tunnel (dome shape). The objective was to evaluate the performance of six tomato hybrids for growth, yield and quality under cooled plastic tunnel conditions. The six tomato hybrids were namely: (SAKER, BARAKA, NIELLY, T.GLORY, DRW6799 and ATHYLA). Randomized complete block design (RCBD) replicated three times was used. Data collection comprised plant growth, yield and fruit quality. The individual and combined ANOVA were performed. statistical analysis showed that there was significant difference among the six hybrids for all of studied characters.The results indicated that the hybrids "T. Glory, ATHYlLA and BARAKA" gave the best yield and fruit quality showing vigorous plant growth with huge canopy, the fruits were round to round-oblate in shape, large size, with attractive red colour, good firmness and long shelf life. The hybrids: T. Glory, ATHYLA and BARAKA could be recommended to be cultivated commercially under cool plastic tunnels conditions in the Sudan.

Keywords: Tomato (*Solanum lycopersicum* Mill.), Hybrids, Cool plastic tunnel, Growth, Yield, Quality

تقييم ستة هجن من الطماطم تحت ظروف الأنفاق البلاستيكية المبردة في السودان

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المستخلص

أجريت التجربة بمحطة بحوث شمبات – هيئة البحوث الزراعية، السودان بهدف تقييم ستة أصناف هجن من الطماطم تحت ظروف الأنفاق البلاستيكية المبردة خلال فصل الصيف (أبريل – اغسطس) لثلاثة مواسم متتالية للسنوات 2012، 2013 و 2014. أصناف الهجن هي صخر، بركة، نيللي، تي قلوري، دراو6799 و أثيلة. تم إستخدام تصميم القطاعات الكاملة العشوائية بثلاث مكررات. أشتمل التقييم علي صفات النمو والنوعية و الإنتاجية. أظهرت نتائج التحليل الإحصائى المنفرد والتجميعي وجود فروقات معنوية بين أصناف الهجن في كل الصفات التي تمت دراستها، كما أظهرت النتائج أن الأصناف الثلاثة تي - قلوري، أثيلة و بركة هي الأفضل من ناحية النمو، الأنتاجية و النوعية، بناءً علي ذلك فان أصناف الهجن الثلاثة تي- قلوري، أثيلة و بركة يمكن التوصية بزراعتها تجارياً تحت ظروف الإنتاج المحمي في الأنفاق البلاستيكية المبردة في السودان.

كلمات مفتاحية: الطماطم، هجن، بيوت بلاستيكية مبردة، النمو، الإنتاجية، النوعية.

Introduction

Vegetable production in the Sudan is developing into a commercial enterprise favoured by such factors like the increasing consumption of vegetables and their products, the increasing economical returns from the activity, the development of several agro-industries and the newly opened export markets for Sudanese vegetables.

Tomato (*Solanum lycopersicum* L.) belongs to the family *Solanaceae,* is believed to be originated in South America where it grows as a perennial crop. It is one of most popular vegetables. Due to its high value as a crop it is distributed throughout the world in large areas with an average production of 146 million metric tons (Taylor and Locascio, 2004; Heuvelink, 2005; FAO, 2010 and FAOSTAT, 2012).

Tomato is considered one of the most important vegetables in Sudan. It currently occupies about 28% of the total area of vegetables grown in Sudan (Ahmed, 2009) with about 950 thousand tons per year. It is an important source of vitamin A. It's considered an anti oxidant, an active compound in the prevention of cancer, cardiovascular risk and in slowing down cellular aging, in addition to vitamins B and C (Gerster, 1997; Di Cesare *et al*., 2012; and Abdel- Monaim, 2012).

Tomato is grown in Sudan in almost all parts of the country during the winter months and rainy season in a wide range of soil conditions. The major production areas are located in Gezira, Sinnar, Blue Nile, White Nile, Khartoum, Northern and Nile States under irrigation from the Nile and under rain fed in Southern Blue and White Nile. (Ahmed, 2009; HAAR, 2010). Tomato yield is very low during summer months (March – June) because of the high temperature, low relative humidity and severe infection by pests and diseases such as Tomato Yellow Leaf Curl Virus (TYLCV) (Omara, 2001). High temperature is considered a major environmental factor that limits tomato production during summer. It adversely affects vegetative growth, flowering and development of tomato plants (Sato *et al.,* 2001, Wahid and Shabbir 2007). Also drying of stigmatic surface leads to reduction in stigma receptivity and tomatoes productivity is decreased (Ansary, 2006 and Elsharief *et. al.,* 2011). The fruit size, ripening and fruit colour formation are

also affected (Mulholland *et al.,* 2003) compared to fruits which matured under optimum temperature conditions. (Abdalla and Verkerk 1970; Hanna and Hernandez, 1982; Ahmed 2009).

Cool plastic tunnel production is a very dynamic economic sector that cope with rapid changes in market trends and consumer preferences. Consequently, choosing the right hybrid for cool plastic tunnel production is essential for the production process (Tuzel and Leonardi 2009).

Vegetables production in cool plastic tunnel has traditionally been located near urban centers. Khartoum State has become an ideal area for future development of this industry, particularly during the summer months when prices of most vegetables particularly tomato are very high.

The tomato hybrids for protected production are indeterminate and require constant maintenance and physical support of the plants for long term fruit production. Indeterminate tomato varieties will need additional nitrogen to continue to grow and produce fruits compared to determinate tomato varieties (Farrer, 2011).

Choosing which hybrid varieties to grow is crucial for successful tomato production under cool plastic tunnels conditions. Up to date, no tomato hybrids have been released for commercial production under cooled plastic tunnels in the Sudan though it is a prerequisite, becoming very important and needs further research and development.

The study aims to evaluating the performance of different tomato hybrid varieties for high productivity and quality under cool plastic tunnels with ultimate goal and identify the suitable one (s) for commercial release under cool plastic tunnels in the Sudan.

Materials and Methods

The experiment was conducted during the summer seasons of the three years: 2012, 2013 and 2014 under cool plastic tunnel at Shambat Research Station, Agricultural Research Corporation (ARC), Sudan, (Lat.15^{o} 40′ N, Long.23^{o} 32′ E, and 380 meters above sea level). The soil is clay loamy type with high content of clay predominantly montemorillonite, slightly alkaline with pH range of 7.5 - 7.7. **Materials:**

Plant material

Six tomato hybrids were used, namely: Athyla, DRW6799, Saker, Baraka, Nielly, and T.Glory.

Cool plastic tunnel

A cool plastic tunnel (dome shape) type is used. It consists of Evaporative cooling fan and pad system to provide 27 ± 5^{o}C temperature and 65 - 77% relative humidity at mid day and covered with polyethylene sheet (200 micron) thick.

Methods

Husbandry

Sowing date was in the first week of April with crop duration extending up to third week of August. The experimental area was prepared in the form of bed 80cm wide “mustaba”. The plot size was 10.3m X 0.80m. Organic fertilizer was added before transplanting. Nursery raised seedlings were planted on the two sides of the 80 cm ridges at 40 cm plant spacing. The plants were fertilized with 20-20-20 formulation on a regular schedule throughout the growing season after transplanting. Micronutrients and foliar fertilizers were applied also with irrigation system. Irrigation was applied using drip system every day for 10 – 15 minutes. Weeding and pruning of side branches were done, chemical insect pests and diseases control, were done when needed.

Harvesting

The crop harvest started after about two months from transplanting with duration differing according to hybrids (Table 1). Fruit picking was done at 3 – 4 days interval for the first month and weekly for the last month.

Data collection

The data recorded included morphological characteristics, yield, and yield components as follows:

- Plant vigour: a scale from 1 (small or poor canopy) to 9 (very large canopy).
- Growth habit: described as indeterminate.
- Fruit set: described as low, medium, high, and very high
- Fruit shape: described as round, semi round, round-oblate, round- flat
- Rind colour: ranged from light red to red colour.
- Fruit weight: calculated as total fruit weight / total number of fruit (g).
- Yield per plant: The total yield of the 5 plants was recorded and the yield per plant was calculated.
- Yield per m^2: The total yield of each experimental unit was recorded and then transformed to yield per m^2
- Fruit diameter: measured using a vernier calibre (cm).
- Total Soluble Solids (TSS): measured using a hand refractometer (^{0}Brix).
- Fruit acidity: the fruit acidity of five randomly selected fruits was determined using Titrable Acid method as described by Ranganna (2001) and the average fruit acidity was calculated.
- Subjective quality analysis: Evaluation tests were performed for tomato fruits by panel of ten persons. They evaluated the sensory characteristics of tomato samples. A questionnaire examining consumer attitudes was developed. The panellists evaluated the product separately and made their scores. The scoring was based on one to five scale. Each panellist was presented with random samples of tomatoes from each variety with three replications. The panellists evaluated the colour, taste, shape and firmness. Also firmness was measured subjectively with the help of fingers pressure.
- **Statistical design and data analysis**

The hybrid varieties were arranged in randomized complete block design (RCBD) with three replications. Data were subjected to separate analysis of variance for traits. Combined ANOVA across the three years was performed to yield per plant and yield per m^2. The means were separated using Duncan's Multiple Range Test (DMRT) at $P \leq 5$ % level. The statistical package GenStat edition 12th was used to run the analysis.

Results and Discussion

Yield and yield components

Tables 2, 3 and 4 show the performance of the studied varieties and the combined analysis across the three years. There were significant differences among hybrids in most parameters measured related to yield and its components. The hybrids T. Glory, Athyla and Baraka recorded the highest yield per plant in terms of number of fruits and fruit weight with the former being the earliest to mature (91 day). The respective yields were 8.3, 7.1 and 6.9 kg/plant. Similarly they showed the highest yield per unit area (m^2) across the three years of 23.5, 21.6 and 21.3 kg/m^2 respectively. The hybrid Saker gave the lowest yield (4.9 kg/plant) and was the latest to mature (105 day). The

two hybrids (T. Glory and Athyla) gave the highest number of fruits per plant (46 and 41 fruits/ plant) and per unit area (136 and 123 fruits/m^2), respectively. Hybrid Saker gave the lowest number of fruits per plant (33). The yield of tomato hybrids obtained by this study was within the range of that reported for tomato hybrids under greenhouse conditions (Elina *et al*. 2017) and this may be attributed to the high plant vigour resulting from the greater photosynthetic area (Elina *et al*. 2017). Other yield ranges for tomato hybrid (11.7 to 15.4kg/m^2) were reported by Hussain, *et al.*, (2002). The fruit number per plant in this study (33 - 46) also agree with the range reported by Yebrzaf *et al*., (2016) who found that number of fruits per plant from other varieties was (26 - 46 fruits). The high yield of tomato plants under cool plastic tunnel obtained in this study could be attributed to plant vigour and high flower set resulting from the extended seasonal production.

Fruit weight (g)

Table 6) shows the significant differences among the hybrids in average fruit weight. Hybrid Baraka gave the biggest fruit weight (200.0 g) followed by T. Glory (180.0g) and Athyla (172.3g), whereas, hybrid Saker showed the smallest fruit weight (140.0g). The highest fruit weight reported by Elina *et al.* 2017 was 160g and the lowest was 79g which was below than that found in this study.

Fruit diameter (cm)

As shown in Table 6 there were significant differences among hybrids in fruit diameter with hybrid Baraka showing the largest fruit diameter (7.2 cm) compared to the other hybrids. The hybrid Saker showed the smallest fruit diameter (4.4 cm). These findings agree with Yebrzaf *et al*. (2016) who find larger fruit diameter (7.3cm), the variation in fruit size and diameter in different tomato varieties is associated with the genetic makeup of the varieties.

Total soluble solids (TSS)

The juice analysis indicated significant difference among varieties for TSS (Table 7). The hybrid Athyla recorded the highest total soluble solids (5.5%) across the three years followed by Baraka (5.1%) and T. Glory (4.5%) while the hybrid Nielly recorded the lowest TSS (3.8). The total soluble solids content is one of the most important quality parameters in tomato. The results of TSS found in this study agree with that reported by Cramer *et al.*, (2001) and Moraru *et al.*, (2004) who mentioned that total soluble solids of different varieties of tomato fruit ranged from 4 to 6 ^{o}Brix, and the significant variation for total soluble solid due to varietal differences.

Acidity

Table 7 illustrates that there was difference among the hybrids in fruit acidity, hybrid Nielly showed highest fruit acidity with an average of (4.7) compared to (3.5) recorded by hybrid Athyla. The findings are in agreement with Amira *et al.* (2013) who found that acidity in the range between 2.52 – 9.05 (g/l citric acid) in other tomato varieties and titratable acidity was found to be highly significant affected by the variety. According to Tigist *et al*. (2011), Tittonell *et al.* (2001) and Meseret (2010) genetic factor is the major determinant of tomato fruits acid content. Also large size tomato fruits have higher acidity than the small size fruit which also noticed in some with some varieties in this study.

Fruits shelf life

Firmness is an important criterion for determining the marketability of tomatoes, because it is associated with good culinary quality and long shelf life. Firmness and keeping quality were better maintained in tomatoes where they retained attractive red colour that could be the main reason for their acceptability by producers and by consumers.

The six hybrids showed differences in the number of stored day at room temperature with and without calyx. Hybrids T. Glory, Athyla, and Saker recorded the longest shelf life when stored with calyx (15, 13 and 12 days) and without calyx (10, 9 and 8 days), while hybrid Nielly showed the shortest shelf life when stored with and without calyx (Table 8). This finding agree with Rehman *et al.,* (2000) who found that some variety has a shelf life of about 15 - 20 days. Also the same trend in shelf life has been reported by Ghosh *et al*. (2010) and Shashikanth *et al*. (2010) they reporting there were varietal differences in shelf life of tomato hybrids and also stated that the differences may due to their genetic characteristics.

Fruit colour, firm, shape and taste

There were a few differences among hybrids in colour, firm, shape and taste. most hybrids were round (Athyla, Baraka and Nielly) while the colour ranged from light red (Nielly) to red.

Results of panel tests for the preferences (panelists) indicate that the consumers prefer some hybrids to other according to their taste. They gave hybrids Athyla, T. Glory and Baraka the highest score in the most of characters tested (Taste, shape, colour, size and firmness) as shown in Table 9.

Conclusions

There is no tomato hybrids released for production under cooled plastic tunnels in Sudan though it is a prerequisite, becoming very important and needs further research and development. The results obtained from three years summer research revealed that out of six hybrids three varieties: T. Glory, Athyla, and Baraka proved to be superior with respect to yield and quality and accepted by the consumers. Therefore, these three varieties: T. Glory, Athyla, and Baraka are suitable for commercial production in Sudan under cool plastic tunnels.

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Table 1: Morphological performance and fruit characteristics of six tomato hybrids evaluated under cooled plastic tunnel during three year summers (2012, 2013 and 2014)

Variety	Plant vigour [a]	Growth habit [b]	Fruit set [c]	Rind colour[d]	Fruit shape [e]	Fruit weight [f]	Firmness [g]	Days to first harvest
T. glory	L	ID	V.H	R	R-O	170-190	VFM	91
Athyla	L	ID	H	R	R	170-180	VFM	94
Baraka	L	ID	H	R	R	200-225	FM	99
DRW6799	M	ID	M	R	RF	190-200	FM	102
Nielly	S	ID	M	L.R	R	140-150	FM	97
Saker	S-M	ID	S	R	SR	140-155	FM	105

a= plant vigour whereas S: small, M: medium, L: large. b= growth habit whereas ID: is indeterminate. c= fruit set whereas S: small, M: medium, H: high, V.H: very high d= rind colour LR: light red, R: red. e= fruit shape R: round, R.O: round oblate, R.F: round flat, S.R: semi round. f= fruit weight: weighted in grams. g= firmness: whereas VFM: very firm, FM: firm.

Table 2: Mean squares form the combined analysis of variance of productivity (weight of fruits/plant and/ m^2) and number of fruits/plant and/m^2) of six tomato hybrids under cooled plastic tunnel during three year summers (2012, 2013 and 2014)

Source of variation	Character												
	Fruit weight							Number of fruit					
	kg/plant				kg/m^2			per plant			per m^2		
	d.f	Mean squares	F value	F prob	Mean squares	F value	F prob	Mean squares	F Value	F prob	Mean squares	F value	F prob
Years	2	2.1035	0.93	0.446	7.4491	0.48	0.641	15.389	0.17	0.849	14.52	0.03	0.970
Hybrids	5	7.7883	413.13	<0.001	62.0602	238.32	<0.001	46.311	40.73	<0.001	431.35	40.05	<0.001
Years* Hybrids	10	0.1759	9.33	<0.001	1.9664	7.55	<0.001	5.367	4.72	<0.001	35.41	3.28	0.006
Error	30	0.0189			0.2604			1.137			10.77		

Table 3: Total fruit yield (number and weight) per plant of six tomato hybrids under cooled plastic tunnel during three year summers (2012, 2013 and 2014)

Hybrid	Yield (kg/plant)			combined mean	Number of fruits/plant			combined mean
	Years				Years			
	2012	2013	2014		2012	2013	2014	
T.GLORY	8.7[a]	7.9[a]	8.2[a]	8.3[a]	48[a]	43[a]	46[a]	46[a]
ATHYLA	7.9[b]	6.4[b]	7.0[b]	7.1[b]	46[b]	37[b]	41[b]	41[b]
BARAKA	7.4[c]	6.6[b]	6.8[b]	6.9[b]	38[c]	34[c]	32[c]	34[b]
DRW\6799	6.2[d]	5.6[c]	5.9[c]	5.9[c]	37[c]	34[c]	36[c]	36[b]
NIELLY	5.8[d]	5.0[d]	5.5[d]	5.4[c]	39[c]	35[c]	39[b]	38[b]
SAKER	5.2[e]	4.4[e]	5.0[e]	4.9[c]	35[d]	31[d]	34[c]	33[b]
Mean	6.9	5.9	6.4	6.4	41	36	38	38
SE±	0.066	0.075	0.063	0.0458	0.574	0.993	0.691	0.3554
LSD(p≤0.05)	0.207	0.213	0.198	1.132	1.709	1.901	2.078	1.027
C.V%	1.4	1.8	1.6	2.0	2.4	2.5	2.9	2.6

Table 4: Total fruit yield (number and weight) per unit area (m^2) of six tomato hybrids under cooled plastic tunnel during three year summers (2012, 2013 and 2014)

Hybrid	yield kg / m^2			combined mean	Number of fruits / m^2			combined mean
	Years				Years			
	2012	2013	2014		2012	2013	2014	
T.GLORY	25.2[a]	23.9[a]	24.4[a]	23.5[a]	136[a]	132[a]	139[a]	136[a]
ATHYLA	23.2[b]	19.9[b]	21.6[b]	21.6[b]	130[b]	116[b]	123[b]	123[b]
BARAKA	22.9[b]	20.0[b]	20.9[b]	21.3[b]	116[c]	103[c]	97[d]	105[c]
DRW6799	19.3[c]	17.5[c]	18.2[c]	18.3[c]	115[c]	105[c]	112[c]	111[c]
NIELLY	17.2[d]	16.0[d]	16.3[d]	16.5[d]	118[c]	113[b]	115[c]	115[c]
SAKER	15.8[e]	14.0[e]	14.7[e]	14.8[e]	107[d]	98[c]	102[d]	102[c]
Mean	20.6	18.6	19.4	19.3	121	111	115	116
SE±	0.357	0.253	0.263	0.1701	1.679	1.725	2.182	1.094
LSD(p≤0.05)	1.124	0.757	0.729	0.4913	5.020	5.135	6.477	3.259

C.V%	2.9	2.2	2.3	2.5	2.3	2.4	3.0	2.6

Table 5: Means of total fruit yield/ plant / unit area (m^2, / $300m^2$, / and / ha) of six tomato hybrids under cooled plastic tunnel during three year summers (2012, 2013 and 2014)

Hybrid	Yield (kg/plant)	yield(kg/m^2)	Yield (tunnel) ton/$300m^2$	yield (ton/ha)
T.GLORY	8.3	23.5	7.1	236.7
ATHYLA	7.1	21.6	6.5	216.7
BARAKA	6.9	21.3	6.4	213.3
DRW6799	5.9	18.3	5.5	183.3
NIELLY	5.4	16.5	4.9	163.3
SAKER	4.9	14.8	4.4	146.7

Table 6: Fruit weight (g) and fruit diameter (cm) of six tomato hybrids under cooled plastic tunnel during three year summers (2012, 2013 and 2014)

Hybrid	Fruit size(g)			Mean	Fruit diameter (cm)			Mean
	Years				Years			
	2012	2013	2014		2012	2013	2014	
T.GLORY	180^{b}	185^{b}	178^{b}	181.0	6.0^{a}	6.7^{a}	5.9^{b}	6.2
ATHYLA	175^{c}	172^{c}	170^{c}	172.3	5.7^{b}	5.6^{b}	5.5^{b}	5.6
BARAKA	200^{a}	195^{a}	210^{a}	201.7	7.1^{b}	7.0^{a}	7.6^{a}	7.2
DRW6799	167^{d}	165^{d}	160^{d}	164.0	5.4^{b}	5.3^{b}	5.1^{b}	5.3
NIELLY	150^{e}	140^{e}	141^{e}	143.7	4.9^{bc}	4.6^{b}	4.6^{b}	4.7
SAKER	140^{f}	135^{f}	145^{e}	140.0	4.5^{bc}	3.9^{b}	4.7^{b}	4.4
Mean	168.7	165.0	167.3		5.6	5.5	5.6	
SE±	1.065	1.411	2.053		1.178	0.533	0.295	
LSD($p \leq 0.05$)	3.033	4.094	5.324		0.523	1.042	0.836	
C.V%	3.4	3.0	4.2		2.0	3.1	2.8	

Table 7: Total soluble solids (brix^{o}) and acidity of six tomato hybrids under cooled plastic tunnel during three year summers (2012, 2013 and 2014)

Hybrid	Total soluble solids			Mean	Acidity			Mean
	Years				Years			
	2012	2013	2014		2012	2013	2014	
T.GLORY	4.6^{b}	4.3^{b}	4.5^{c}	4.5	4.3^{a}	4.0^{a}	4.0^{b}	4.1
ATHYLA	5.5^{a}	5.2^{a}	5.8^{a}	5.5	3.6^{bc}	3.3^{a}	3.5^{bc}	3.5
BARAKA	5.3^{a}	4.9^{a}	5.0^{b}	5.1	3.9^{bc}	3.5^{a}	3.6^{bc}	3.7

DRW6799	4.4[b]	4.3[b]	4.1[d]	4.3	4.0[bc]	4.1[a]	4.0[b]	4.0
NIELLY	3.8[b]	4.0[b]	3.7[e]	3.8	4.9[a]	4.6[a]	4.7[a]	4.7
SAKER	4.1[b]	4.0[b]	3.9[e]	4.0	4.5[b]	4.3[a]	4.2[b]	4.3
Mean	4.6	4.5	4.5		4.2	3.9	4.0	
SE±	0.384	0.171	0.057		0.151	0.617	0.138	
LSD(p≤0.05)	0.813	0.542	0.264		0.345	1.034	0.411	
C.V%	2.7	3.7	2.0		1.8	2.7	2.2	

Table 8: Fruits shelf life (days with and without calyx) of six tomato hybrids under cooled plastic tunnel during three year summers (2012, 2013 and 2014)

Hybrid	**Fruit shelf life with calyx (days)**			**Mean**	**Fruit shelf life without calyx (days)**			**Mean**
	Years				**Years**			
	2012	2013	2014		2012	2013	2014	
T.GLORY	16[a]	14[a]	14[a]	15	10[a]	9[a]	10[a]	10
ATHYLA	14[b]	12[b]	13[a]	13	10[a]	9[a]	9[b]	9
BARAKA	10[c]	9[c]	10[b]	10	7[c]	6[b]	6[d]	6
DRW6799	11[c]	8[c]	9[b]	9	7[c]	4[c]	4[c]	5
NIELLY	8[d]	9[c]	6[c]	8	4[c]	6[b]	3[c]	4
SAKER	13[b]	12[b]	11[b]	12	8[b]	8[a]	7[b]	8
Mean	12	11	11		8	7	7	
SE±	0.605	0.566	0.683		0.576	0.306	0.483	
LSD(p≤0.05)	0.754	0.925	1.043		1.708	0.931	1.513	
C.V%	2.7	3.0	3.2		2.9	3.4	3.1	

Table 9: Fruit panel test of six tomato hybrid varieties under cooled plastic tunnel (full score = 5)

Hybrid	**Fruit panel test**			
	Colour	Firm	Shape	Taste
T.GLORY	4.6^{a}	4.7^{a}	4.4^{a}	4.2^{b}
ATHYLA	4.0^{b}	4.5^{ab}	4.3^{a}	5.0^{a}
BARAKA	3.8^{bc}	4.2^{bc}	4.3^{a}	4.0^{b}
DRW6799	3.6^{bc}	4.1^{bcd}	4.2^{a}	3.7^{c}
NIELLY	3.5^{bc}	4.0^{cde}	3.5^{b}	3.5^{c}
SAKER	3.3^{c}	3.7^{de}	3.5^{b}	3.4^{c}
SE±	0.1540	0.1856	0.0839	0.1568
LSD($p \leq 0.05$)	0.3430	0.4135	0.1869	0.3494
C.V%	5.2	5.4	2.5	5.1