

## **PRODUCTION AND EVALUATION OF SOME TOMATO HYBRIDS FOR LOW TUNNEL CULTURE**

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### **ABSTRACT**

Fifteen true-breeding tomato cvs. were evaluated as potential parents for hybrids, along with the commercial hybrid Alwadi in the 1997/1998 winter season under low tunnels using a drip-irrigation system. Cultivar Supermarmande had the highest values of plant height (PH), fruit set (FS) percentage and number of locules (NL) per fruit. Cvs. Scotia, Siberia and Oregon Spring V had the highest early yield (EY). Cvs. Siletz and Mountain Gold VFF gave the highest total yield (TY). Cultivar Mountain Gold VFF gave the highest marketable yield (MY). Hybrid Alwadi and cv. Mountain Gold VFF produced the heaviest fruits. Cvs. Apex 1000 and Mountain Gold VFF produced the firmest fruits. Cultivar Burgess Stuffing had the highest fruit total soluble solids (TSS) content. Cvs. Long-Keeper and Apex 1000 had the highest percentage of titratable acidity (TA) over all evaluated cvs. Hybrid Alwadi had significantly the highest fruit ascorbic acid (AA) content.

Based on former results of the 1997/ 1998 winter season evaluation trial, 7 cvs. were chosen as parents to produce 21 F<sub>1</sub> hybrids in one direction. These F<sub>1</sub> hybrids were evaluated along with hybrid Alwadi and true-breeding cv. Supermarmande as controls during the 1998/1999 and 1999/2000 winter seasons under low tunnels using the drip-irrigation system.

In the two seasons, the hybrids Campbell 1327 VF × Scotia and Supermarmande × Scotia were superior in some characters. The hybrid Campbell 1327 VF × Scotia produced the highest values of percentage FS, TY and MY, but it was second in EY. Also, it had average fruit weight (AFW) more than 100 g in the first season and 99.0 g in the second one. It also had round fruits having medium values of each of fruit firmness (FF), NL, TSS, TA percentage and AA content. The hybrid Supermarmande × Scotia was the second in TY and MY. It also produced round fruits with an AFW about 66 g having medium values of each of FF, NL and AA content. Fruit TSS was high, being 5.8.

*Key words : Lycopersicon esculentum, Low tunnel hybrids, Percentage fruit set, Yield components, Fruit quality.*

## INTRODUCTION

Large areas are planted with tomato under polyethylene low tunnels. The area has been estimated as 45000 feddans in 2000, mostly in sandy soil in the desert area in lower Egypt (Ministry of Agriculture and Land Reclamation, Egypt, 2000).

The tomato production under polyethylene low tunnels has filled the gap between seasons, i.e., during March and April, where tomato production is usually low. This is due to the problem of fruit set under the prevailing low temperature during the open field winter planting.

Hybrids are generally utilized in protected cultivation. The hybrids are preferred to the true-breeding cultivars due to their high yielding ability, uniformity, better fruit quality, and disease resistance. All seed companies have now shifted their production to  $F_1$ 's due to these advantages and also to be in control of their hybrid seed production and sale. Unfortunately, all tomato seeds planted in Egypt are imported from foreign companies. Total annual imports reached about 500 kg in 2000 costing about L.E. 4 millions. Attention, should be given to the production of tomato hybrids adapted to local conditions.

According to Baggett and Kean (1986), Oregon Spring was released as a facultative parthenocarpic cv. as it sets parthenocarpic fruits at low temperature. It is an early cv. that is capable of fruit set in cold weather. The fruit is 150-160 g, multilocular and soft with mild and slightly acid flavor (pH= 4.2) and contains 25.9 mg% of vitamin C at optimum ripeness. Gardner (1993) reported that Mountain Gold fruits are globe to flattened globe and the ripe fruit is firm. The average fruit weight is 313-318 g, early yield 23-26 t/ha, total yield 93-101 t/ha and marketable yield 82-90 t/ha.

Siletz is a facultative parthenocarpic tomato cv. capable of setting fruits in low temperature. Average fruit weight was 149-195 g. Fruits are multilocular and "meaty". Fruit firmness is only fair. The pH of Siletz fruits was 4.4 ( Baggett *et al* 1997). Philouze *et al* (1978) evaluated 70 true-breeding cvs. and hybrids for capacity to produce sufficient amounts of good-quality pollen in an unheated greenhouse, and they found that Supermarmande was one of the best 10 genotypes in this respect.

Youssef *et al* (1994) evaluated 29 genotypes under plastic low tunnels and selected cv. Supermarmande as one of the best performing cvs. It gave higher early and total yield than most of the other tested cvs. The multilocular fruit of this cv. was medium in size, oblate and soft.

Mohamed (1997 and 1998) found that the parthenocarpic cv. Nadja produced high early fruit yield.

This study was conducted to : (a) evaluate potential parental tomato cvs. for hybrid production and (b) study hybrid vigor in some intervarietal crosses to develop new tomato hybrids with high yielding ability and good fruit quality.

## MATERIALS AND METHODS

This study was conducted during the period from 1997 to 2000. Crosses and transplant production were carried out in the greenhouse facilities of Kaha Vegetable Research Farm (KVRF), Kalubia, while evaluations were conducted using a drip-irrigation system under low tunnels during the winter seasons at Ali Mubarak Village Research Farm (AMVRF), South El-Tahrir Horticulture Research Station (STHRs), Behairah.

Fifteen tomato true-breeding cvs. and one commercial hybrid were evaluated under low tunnels during the 1997/ 1998 winter season for plant height, yield (early, total and marketable) and fruit quality characters, in order to select the potential parents for hybrid production. Cultivars evaluated were Baxter's Early-Bush, Burgess Stuffing, 506 Bush, Campbell 1327 VF, Long-Keeper, Mountain Gold VFF, Oregon Spring V, Scotia, Siberia, Siletz (Tomato Growers Supply Company, USA), Castlerock, Supermarmande (Petoseed Company, USA), Apex 1000, Yuba (Ferry-Morse Seed Company, USA) and Orion (Harris-Moran Seeds, USA). Hybrid Alwadi (Petoseed) was also included as a control.

Seeds of these genotypes were sown on October 9, 1997 in the greenhouse and transplanted on November 26, 1997 under low tunnels in AMVRF. A randomized complete block design (RCBD) with 3 replicates was used. Each experimental plot (EP) consisted of 1 bed, 1m wide and 10 m long (EP = 10 m<sup>2</sup>). Plants were set 50 cm apart along the drip-irrigation tube and were given common agricultural practices.

The various genotypes were evaluated with regard to the following characters:

1. **Foliage and fruit set** : plant height (PH) from soil surface to the highest growing tip measured as an average of 5 randomly chosen plants per EP and percentage of fruit set (FS) in flowers borne on all clusters produced by 5 randomly chosen plants per EP.

2. **Yield** : early yield (EY) measured as the yield of the first 3 pickings, total yield (TY) measured as the weight of all fruits harvested at the red ripe stage from each EP and marketable yield (MY) as determined after excluding cracked, sunburned, and rotted fruits and fruits infected with diseases and pests.
3. **Fruit quality** : average fruit weight (AFW) was determined as the mean weight of 20 fruits randomly chosen from each EP, fruit shape index (FSI) was calculated as the ratio of fruit length to fruit diameter. Each EP was represented by 20 fruits. Oval fruit shape is usually considered for a ratio of 1.2 or more, round shape for a ratio of 0.95 – 1.2, and oblate shape for a ratio less than 0.95 (Yeager 1937). Fruit firmness (FF) was measured in the red-ripe stage using a needle type pocket penetrometer. Five readings were taken for each fruit by pushing the penetrometer needle slowly at 5 different sites; one reading being near the shoulder, another one at the blossom end, and 3 readings at the equatorial plane, then mean of the 5 readings was calculated. Each EP was represented by 5 fruits. Number of locules (NL) per fruit was determined in a sample of 10 fruits per EP. Total soluble solids (TSS) was determined in at least 5 red-ripe fruits of each EP using a hand refractometer. Fruit pH was determined by immersing the glass electrode of a pH meter in juice extracted from 200 g of a red-ripe fruit sample per EP. Titratable acidity (TA) was ascertained using 0.1 N NaOH solution and phenolphthalein as indicator, and ascorbic acid (AA) content was determined using 2,6 dichlorophenol indophenol dye (AOAC 1990).

During the above-described evaluation trial of the 15 true - breeding cvs., all possible crosses among them, i.e., 105 crosses, were produced for the purpose of saving one season by insuring securing seeds of the potential desired crosses by the end of the evaluation trial in June 1998. Upon evaluation of these genotypes, the best 7 cvs., based on all characters measured, were selected as parents for the hybrids, and the seeds of the 21 possible crosses among them in one direction ( Table 1 ) were saved. Seeds of the remaining 84 crosses were discarded. More F<sub>1</sub> seeds of the 21 desired hybrids were also produced in the greenhouse facilities of KVRF during the 1998/1999 winter season.

**Table 1. Selected genotypes and crosses among them.**

<b>Females</b>	<b>Males</b>	<b>Number of hybrids</b>
<b>Apex 1000</b>	<b>Campbell 1327 VF, Oregon Spring V, Scotia, Siletz</b>	<b>4</b>
<b>Campbell 1327 VF</b>	<b>Oregon Spring V, Scotia, Siletz</b>	<b>3</b>
<b>Oregon Spring V</b>	<b>Siletz</b>	<b>1</b>
<b>Orion</b>	<b>Apex 1000, Campbell 1327 VF, Oregon Spring V, Scotia, Siletz</b>	<b>5</b>
<b>Scotia</b>	<b>Oregon Spring V, Siletz</b>	<b>2</b>
<b>Supermarmande</b>	<b>Apex 1000, Campbell 1327 VF, Oregon Spring V, Orion, Scotia, Siletz</b>	<b>6</b>
<b>Total</b>		<b>21</b>

The 21 above-listed F<sub>1</sub> hybrids (Table 1) were evaluated along with hybrid Alwadi, and true-breeding cv. Supermarmande as controls during the 1998/1999 and 1999/2000 winter seasons under low tunnels using the drip irrigation system. Seeding and transplanting dates were, respectively, September 29 and November 24 in the first season (1998/1999) and October 14 and November 21 in the second season (1999/2000). In each evaluation trial a RCBD with 3 replicates was used. Each EP, i.e., one hybrid or control genotype per replicate, consisted of 1 bed, 1 m wide and 10 m long (EP area = 10 m<sup>2</sup>).

All entries, i.e., hybrids produced and control genotypes, were evaluated with regard to foliage height, fruit set, yield (total, early and marketable) and fruit quality attributes as previously described. Data obtained were statistically analysed according to Gomez and Gomez (1984) and mean comparisons were based on the New LSD test (Waller and Duncan 1969).

## RESULTS AND DISCUSSION

Data obtained on fifteen tomato true-breeding cvs. and one commercial hybrid evaluated under low tunnels during the 1997/1998 winter season to select potential parents of F<sub>1</sub> hybrids are presented in Tables (2) and (3) .

Cultivar Supermarmande had the highest PH, but it was not significantly different from cv. Baxter's Early-Bush. Cultivar Siberia had the shortest PH (Table 2) .

Cultivar Supermarmande gave the highest FS percentage, but it was not significantly different from cvs. Scotia, Mountain Gold VFF and Oregon Spring V (Table 2). Therefore, these cvs. had the ability to set fruits under low temperatures. These results are in agreement with results of Philouze *et al* (1978) who found that cv. Spermarmande was one of the best 10 genotypes in producing sufficient amounts of good-quality pollen in an unheated greenhouse. Also, Baggett and Kean (1986) reported that cv. Oregon Spring V was facultative parthenocarpic tomato cv.

**Table 2. Plant height, fruit set percentage, and early, total and marketable yield of tomato genotypes evaluated in the 1997/1998 winter season.**

Genotype	Plant height (cm)	Fruit set (%)	Early yield (ton/feddan)	Total yield (ton/ feddan)	Marketable yield (ton/feddan)
Alwadi	84.4 cde	50.80 bc	0.05 c	10.54 bcd	10.54 abc
Apex 1000	85.9 bed	41.30 ef	0.02 c	4.70 ef	4.70 def
Baxter's Early-Bush	96.9 a	42.70 de	0.09 c	2.82 f	2.82 f
Burgess Stuffing	87.8 bc	40.40 ef	—	6.47 cdef	6.47 cdef
506- Bush	75.2 ghi	31.70 g	—	4.44 ef	4.44 ef
Campbell 1327 VF	90.9 b	41.10 ef	0.20 c	7.59 bcdef	7.59 abcdef
Castlerock	80.0 efg	48.40 cd	—	6.20 cdef	6.20 bcdef
Long- Keeper	77.0 fgh	36.10 fg	—	3.40 f	3.40 f
Mountain Gold VFF	80.4 defg	53.70 abc	—	12.57 ab	12.57 a
Oregon Spring V	71.1 i	53.30 abc	0.83 a	9.78 bcde	9.78 abcde
Orion	86.5 bc	40.20 ef	0.06 c	2.60 f	2.60 f
Scotia	72.4 hi	57.10 ab	1.01 a	9.70 bcde	9.67 abcde
Siberia	52.0 k	51.20 bc	0.85 a	5.64 cdef	5.47 bcdef
Siletz	64.2 j	51.00 bc	0.55 b	16.94 a	10.46 abcd
Supermarmande	97.4 a	59.80 a	—	11.16 bc	11.16 ab
Yuba	82.3 cdef	40.60 ef	0.16 c	5.16 def	5.16 cdef
New LSD 0.05	5.9	6.54	0.23	5.63	5.83

**Table 3. Fruit quality of tomato genotypes evaluated in the 1997/1998 winter season.**

Genotype	Average fruit weight (g)	Fruit shape index	Fruit firmness (g/cm <sup>2</sup> )	Number of locules	TSS (%)	pH value	Titrateable acidity (%)	Ascorbic acid content (mg/100g fresh weight)
Alwadi	162.90 a	0.82 hi	539.4 ef	5.30 bc	4.80 bcd	4.28 bc	0.58 hi	17.40 a
Apex 1000	83.30 fg	1.27 a	1023.0 a	2.20 fg	4.50 cd	4.39 bc	0.92 ab	11.10 e
Baxter's Early-Bush	13.20 i	1.12 c	316.2 i	2.00 g	2.80 e	4.26 bc	0.50 i	13.20 cd
Burgess Stuffing	74.90 fg	0.99 e	465.0 fg	2.40 f	5.80 a	4.43 abc	0.78 cde	11.10 e
506- Bush	115.70 d	0.79 i	623.1 d	5.20 c	5.00 abcd	4.76 a	0.85 bcd	11.20 e
Campbell 1327 VF	143.40 b	0.79 i	539.4 ef	5.60 b	5.20 abc	4.45 abc	0.70 ef	11.40 e
Castlerock	98.40 e	1.07 d	604.5 de	3.70 e	4.80 bcd	4.58 ab	0.60 fghi	12.80 d
Long-Keeper	96.70 e	0.91 fg	558.0 de	3.50 e	4.20 d	4.57 ab	1.00 a	11.60 e
Mountain Gold VFF	158.50 a	0.85 h	948.6 ab	5.60 b	5.50 ab	4.51 ab	0.65 fgh	12.30 de
Oregon Spring V	84.70 f	0.80 i	362.7 hi	4.40 d	4.80 bcd	4.16 c	0.88 bc	11.40 e
Orion	72.20 g	1.18 b	846.3 c	2.00 g	5.50 ab	4.40 bc	0.79 cde	11.30 e
Scotia	79.90 fg	0.94 f	427.8 gh	3.40 e	5.50 ab	4.39 bc	0.82 bcd	15.10 b
Siberia	51.00 h	0.89 g	334.8 i	4.20 d	4.20 d	4.28 bc	0.59 ghi	14.40 bc
Siletz	127.70 c	0.71 j	334.8 i	6.50 a	4.80 bcd	4.29 bc	0.79 cde	12.00 de
Supermarmande	145.00 b	0.69 j	381.3 hi	6.70 a	5.30 abc	4.35 bc	0.69 efg	11.20 e
Yuba	73.60 fg	1.17 b	939.3 b	2.50 f	4.70 bcd	4.30 bc	0.77 de	12.10 de
New LSD 0.05	11.25	0.04	82.77	0.39	0.87	0.34	0.11	1.23

Data obtained on yield and its components are presented in Table (2). Results showed that cv. Scotia had the highest EY, but without significant difference from cvs. Siberia and Oregon Spring V. These 3 cvs. were significantly different from all evaluated cvs. (Table 2). These results are in agreement with Baggett and Kean (1986) who found that cv. Oregon Spring V was an early cv. Meanwhile, Mohamed (1997 and 1998) found that the parthenocarpic cv. Nadja produced high early fruit yield. Cultivar Siletz gave the highest TY, but it was not significantly different from cv. Mountain Gold VFF (Table 2). These results are in agreement with results of Gardner (1993) who reported that TY of cv. Mountain Gold VFF was 93-101 t/ha. Cultivar Mountain Gold VFF gave the highest MY, but it was not significantly different from cvs. Supermarmande, Siletz, Oregon Spring V, Scotia and Campbell 1327 VF and the hybrid Alwadi (Table 2). These results are in agreement with the findings of Gardner (1993) concerning cv. Mountain Gold VFF. He reported that the MY of this cv. was 82-90 t/ha.

Data obtained on fruit quality characters are presented in Table (3). The hybrid Alwadi produced the heaviest fruits, but it was not significantly different from cv. Mountain Gold VFF. Average fruit weight in cvs. Supermarmande, Campbell 1327 VF, Siletz and 506 Bush was more than 100 g (Table 3). These results disagree with those of Gardner (1993) and Baggett *et al* (1997) who found, respectively, that the AFW of cvs. Mountain Gold VFF and Siletz were 313-318 g and 149-195 g. The reduction of AFW of these cvs. in this study may be due to the difference in environmental conditions. Cultivars Apex 1000, Orion and Yuba produced oval fruits, meanwhile cvs. Baxter's Early-Bush, Castlerock and Burgess Stuffing had round fruits. The remaining cvs. produced oblate fruits (Table 3). Cultivar Apex 1000 produced the firmest fruits, but its fruits were not significantly different in firmness from those of cv. Mountain Gold VFF (Table 3). These results are in agreement with those of some investigators as fruits of cv. Oregon Spring V were soft (Baggett and Kean 1986), fruits of cv. Mountain Gold VFF were firm (Gardner 1993), fruits of cv. Supermarmande were soft (Youssef *et al* 1994) and fruit firmness of cv. Siletz was only fair (Baggett *et al* 1997). Cultivar Supermarmande had the largest NL per fruit, but it was not significantly different from cv. Siletz. Also, cvs. Mountain Gold VFF, Campbell 1327 VF, 506 Bush, Oregon Spring V and Siberia and the hybrid Alwadi produced fruits having more than 4 locules. The least NL per fruit was found in cvs. Orion and Baxter's Early-Bush (Table 3). These results are in agreement with Baggett and Kean (1986), Youssef *et al* (1994) and Baggett *et al* (1997) who, respectively,



found that cvs. Oregon Spring V, Supermarmande and Siletz produced multilocular fruits. Cultivar Burgess Stuffing had the highest TSS content, but it was not significantly different from cvs. Mountain Gold VFF, Orion, Scotia, Supermarmande, Campbell 1327VF and 506 Bush (Table 3).

Cultivar 506 Bush had the highest fruit pH, but it was not significantly different from cvs. Castlerock, Long-Keeper, Mountain Gold VFF, Campbell 1327 VF and Burgess Stuffing. The least fruit pH was found in cv. Oregon Spring V (Table 3). These results coincided with those of Baggett and Kean (1986) who found that the pH of fruits of cv. Oregon Spring V was 4.2. Also, pH of cv. Siletz fruits was 4.4 (Baggett *et al* 1997). Cultivar Long-Keeper had the highest percentage of TA over all evaluated cvs., but it was not significantly different from cv. Apex 1000. Cultivar Baxter's Early-Bush had the least value of TA percentage (Table 3). Hybrid Alwadi had the highest fruit AA content and was significantly different from all other evaluated cvs. Also, cvs. Scotia and Siberia contained 15.1 and 14.4 mg vitamin C/100g fresh weight, respectively. Cultivars Apex 1000 and Burgess Stuffing had the least fruit vitamin C content (Table 3). These results disagree with those of Baggett and Kean (1986) who determined vitamin C content of cv. Oregon Spring V as 25.9 mg% at optimum ripeness versus 11.4 mg% in the present study. This contradiction in results can be explained depending on the fact that environmental conditions have a great influence on fruit AA content.

Based on this evaluation, 7 cvs. were chosen as parents to produce 21 F<sub>1</sub> hybrids in one direction as previously mentioned in Table (1).

### **Plant Height**

Data obtained on PH in the 1998/1999 and 1999/2000 winter seasons are presented in Table (4). In the first season, the hybrid Apex 1000 × Siletz had the highest PH, but it was not significantly different from most of other evaluated genotypes. The shortest PH was found in the hybrids Campbell 1327 VF × Scotia and Oregon Spring V × Siletz. In the second season, cv. supermarmande had the highest PH, but it was not significantly different from hybrids Apex 1000 × Siletz and Campbell 1327 VF × Siletz. The shortest PH was observed in hybrids Oregon Spring V × Siletz and Campbell 1327 VF × Scotia. It was evident from results of the two seasons that these two hybrids were suitable for growing under low tunnels in comparison with other evaluated genotypes.

**Table 4. Plant height and fruit set percentage of tomato genotypes evaluated in the 1998/1999 and 1999/2000 winter seasons.**

Genotype	Plant height (cm)		Fruit set (%)	
	1998/1999	1999/2000	1998/1999	1999/2000
<b>Controls:</b>				
Alwadi (F <sub>1</sub> hybrid)	86.3 abc	87.7 defg	55.30 efgh	49.70 de
Supermarmande (true-breeding)	87.0 abc	96.9 a	56.80 defg	57.10 bcd
<b>Hybrids produced:</b>				
Apex 1000 × Campbell 1327 VF	88.1 ab	90.9 bcde	67.20 abc	57.00 bcd
Apex 1000 × Oregon Spring V	82.9 bc	80.4 ijk	62.20 bcdef	55.10 cd
Apex 1000 × Scotia	84.1 abc	81.6 hij	60.70 cdef	38.60 f
Apex 1000 × Siletz	92.7 a	95.0 ab	60.00 cdef	51.30 de
Campbell 1327 VF × Oregon Spring V	86.3 abc	85.2 efghi	64.30 abcde	52.60 cde
Campbell 1327 VF × Scotia	68.4 d	67.9 l	74.30 a	68.40 a
Campbell 1327 VF × Siletz	88.2 ab	93.5 abc	47.50 gh	39.50 f
Oregon Spring V × Siletz	69.4 d	66.8 l	45.90 h	37.90 f
Orion × Apex 1000	85.9 abc	87.1 defgh	53.50 fgh	45.60ef
Orion × Campbell 1327 VF	79.1 c	75.6 k	56.50 defg	56.00 cd
Orion × Oregon Spring V	87.9 ab	91.1 bed	60.60 cdef	56.80 cd
Orion × Scotia	86.7 abc	77.5 jk	61.80 bcdef	51.30 de
Orion × Siletz	86.7 abc	87.1 defgh	56.50 defg	55.90 cd
Scotia × Oregon Spring V	90.7 ab	90.2 bcde	56.60 defg	51.70 de
Scotia × Siletz	85.0 abc	87.4 defg	60.03 cdef	54.20 cd
Supermarmande × Apex 1000	84.8 abc	82.2 ghij	71.50 ab	60.10 bc
Supermarmande × Campbell 1327 VF	82.7 bc	78.1 jk	64.60 abcde	59.60 bc
Supermarmande × Oregon Spring V	86.5 abc	88.5 cdef	65.40 abcd	56.10 cd
Supermarmande × Orion	86.1 abc	82.6 ghij	64.80 abcde	51.60 de
Supermarmande × Scotia	85.2 abc	84.1 fghi	67.80 abc	64.70 ab
Supermarmande × Siletz	87.1 abc	85.7 defghi	54.20 fgh	51.20 de
New LSD 0.05	8.8	5.8	10.07	7.80

## Percentage of Fruit Set

Data obtained on percentage of FS in the 1998/1999 and 1999/2000 winter seasons are presented in Table (4). The hybrid Campbell 1327 VF × Scotia gave the highest FS percentage in the two seasons, but it was not significantly different from hybrids Supermarmande × Apex 1000, Supermarmande × Scotia, Apex 1000 × Campbell 1327VF, Supermarmande × Oregon Spring V, Supermarmande × Orion, Supermarmande × Campbell 1327VF and Campbell 1327VF × Oregon Spring V in the first season and from the hybrid Supermarmande × Scotia in the second one. In the first season, most hybrids were generally superior to controls in FS percentage. Hybrid Oregon Spring V × Siletz produced the least FS percentage in the two seasons. Results of the two seasons proved that hybrid Campbell 1327 VF × Scotia and some hybrids having Supermarmande as one of their parents were capable of setting fruits under low temperatures. These results are in agreement with Philouze *et al* (1978) as they reported that cv. Supermarmande was one of the best genotypes in the ability to produce sufficient amounts of good-quality pollen in an unheated greenhouse. Also, Youssef *et al* (1994) selected cv. Supermarmande as one of the best performing cvs. under plastic low tunnels.

## Yield and its Components

Data obtained on early, total and marketable yield in the 1998/1999 and 1999/2000 winter seasons are presented in Table (5). In the two seasons, the hybrid Oregon Spring V × Siletz produced the highest EY and was significantly different from all other evaluated genotypes. The hybrid Campbell 1327 VF × Scotia was the second in EY and was also significantly different from other evaluated genotypes (Table 5). The hybrid Campbell 1327 VF × Scotia had the highest TY over all genotypes evaluated in the two seasons. It was not significantly different from hybrids Supermarmande × Scotia, Scotia × Oregon Spring V, Apex 1000 × Siletz and Orion × Oregon Spring V and cv. Supermarmande in the two seasons beside the hybrid Supermarmande × Campbell 1327 VF in the second season (Table 5). Generally, most hybrids produced higher TY than the hybrid Alwadi (control). These results coincided with that of Youssef *et al* (1994) as they found that cv. Supermarmande gave higher TY than most of the other tested cvs. under plastic low tunnels. In the two seasons, the hybrid Campbell 1327 VF × Scotia had the highest MY over all evaluated genotypes. It was not significantly different from hybrids Supermarmande × Scotia, Apex 1000 × Siletz and Orion × Oregon Spring V and cv. Supermarmande in the two

**Table 5. Early, total and marketable yield (ton/feddan) of tomato genotypes evaluated in the 1998/1999 and 1999/2000 winter seasons.**

Genotype	Early yield		Total yield		Marketable yield	
	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000
<b><u>Controls:</u></b>						
Alwadi (F <sub>1</sub> hybrid)	0.69 cde	0.56 cd	19.04 fgh	13.88 efghi	16.53 gh	10.99 ghi
Supermarmande (true-breeding)	0.52 defgh	0.44 cdef	29.62 ab	22.52 ab	26.31 abc	18.71 abc
<b><u>Hybrids produced:</u></b>						
Apex 1000 × Campbell 1327 VF	0.26 hijkl	0.23 efghi	19.08 fgh	13.92 defghi	17.65 fgh	12.11 defghi
Apex 1000 × Oregon Spring V	0.06 kl	0.04 hi	18.75 fgh	13.59 fghi	17.22 fgh	11.68 fghi
Apex 1000 × Scotia	0.18 ijkl	0.16 fghi	16.42 h	11.26 hi	14.83 h	9.30 i
Apex 1000 × Siletz	0.60 cdefg	0.47 cdef	26.33 abc	19.20 abcd	24.81 abcd	17.21 abcd
Campbell 1327 VF × Oregon Spring V	0.63 cdef	0.50 cde	23.62 cdef	17.34 bcdefg	21.38 def	14.80 cdefgh
Campbell 1327 VF × Scotia	2.19 b	2.06 b	30.85 a	23.72 a	29.13 a	21.52 a
Campbell 1327 VF × Siletz	0.14 jkl	0.12 ghi	20.22 defgh	13.94 defghi	18.09 fgh	11.51 fghi
Oregon Spring V × Siletz	4.27 a	4.14 a	25.20 bcd	18.07 bcdefg	23.55 cd	16.97 abcde

*Continued*

Table 5. Continued.

Genotype	Early yield		Total yield		Marketable yield	
	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000
Orion × Apex 1000	0.40 efghij	0.32 defgh	21.97 cdefg	15.69 cdefghi	21.12 defg	14.54 cdefgh
Orion × Campbell 1327 VF	0.01 l	0.00 i	18.33 gh	13.17 ghi	17.41 fgh	11.88 efghi
Orion × Oregon Spring V	0.51 defgh	0.44 cdef	26.19 abc	19.09 abcde	24.77 abcd	16.86 abcde
Orion × Scotia	0.02 kl	0.007 hi	16.06 h	10.90 i	15.30 h	9.77 hi
Orion × Siletz	0.33 fghijk	0.28 defghi	24.58 cde	18.30 bcdefg	23.31 cde	15.71 cdefg
Scotia × Oregon Spring V	0.86 c	0.72 c	26.60 abc	19.47 abc	24.16 bed	16.55 abcdef
Scotia × Siletz	0.51 defgh	0.44 cdef	20.07 efgh	13.49 ghi	18.32 fgh	12.79 defghi
Supermarmande × Apex 1000	0.29 ghijkl	0.27 defghi	19.79 efgh	14.63 cdefghi	18.51 efgh	11.93 efghi
Supermarmande × Campbell 1327 VF	0.30 ghijkl	0.22 efghi	25.13 bcd	18.85 abcdef	23.85 bcd	16.25 bcdef
Supermarmande × Oregon Spring V	0.39 efghij	0.31 defghi	25.26 bc	18.13 bcdefg	23.19 cde	16.61 abcdef
Supermarmande × Orion	0.48 defghi	0.41 cdefg	22.66 cdefg	16.35 cdefgh	21.43 def	14.85 cdefgh
Supermarmande × Scotia	0.72 cd	0.58 cd	30.02 ab	22.59 ab	28.68 ab	21.08 ab
Supermarmande × Siletz	0.68 cde	0.55 cd	23.64 cdef	17.36 bcdefg	21.22 defg	14.82 cdefgh
New LSD 0.05	0.32	0.32	4.99	5.32	4.85	5.15

seasons beside the hybrids Oregon Spring V × Siletz, Supermarmande × Oregon Spring V and Scotia × Oregon Spring V in the second season (Table 5). Generally, hybrids produced higher MY than the hybrid Alwadi (control), but it was not significantly different from cv. Supermarmande (control).

### **Fruit Quality**

Data obtained on fruit quality in the 1998/1999 and 1999/2000 winter seasons are presented in Tables (6) and (7). In 1998/1999 season, the hybrid Supermarmande × Campbell 1327 VF, cv. Supermarmande and hybrids Oregon Spring V × Siletz and Campbell 1327 VF × Oregon Spring V produced the heaviest fruits over all evaluated hybrids with AFW being 128.3, 126.3, 122.3, and 116.3 g, respectively. These genotypes were not significantly different from the hybrid Alwadi. Also, the hybrids Supermarmande × Siletz, Campbell 1327 VF × Scotia and Campbell 1327 VF × Siletz were second in AFW. They all averaged more than 100 g/fruit and were not significantly different from each other. In 1999/2000 season, cv. Supermarmande gave the heaviest fruits over all evaluated hybrids, but it was not significantly different from hybrids Supermarmande × Campbell 1327 VF and Alwadi. Hybrids Campbell 1327 VF × Oregon Spring V, Oregon Spring V × Siletz, Supermarmande × Siletz and Campbell 1327 VF × Siletz were second in AFW. They all averaged more than 100 g/ fruit and were not significantly different from each other (Table 6).

In the two seasons, the hybrid Campbell 1327 VF × Scotia was superior in some characters. It produced the highest value of percentage FS, TY and MY, but it was second in EY. Also, it had AFW more than 100 g in the 1998/1999 winter season, and 99.0 g in the 1999/2000 winter season. Moreover, its PH was suitable for growing under low tunnels.

The hybrid Orion × Apex 1000 had the highest FSI value in the two seasons. Also, in the two seasons, the hybrids Orion × Apex 1000, Orion × Oregon Spring V, Apex 1000 × Siletz, Supermarmande × Apex 1000, Orion × Campbell 1327 VF, Campbell 1327VF × Scotia, Apex 1000 × Campbell 1327 VF, and Apex 1000 × Scotia produced round fruits while the remaining evaluated genotypes produced oblate fruits (Table 6). In the two seasons, the hybrid Apex 1000 × Siletz was the highest in FF. In the first season, it was significantly different from all other evaluated genotypes; meanwhile, in the second one it was not significantly different from the hybrid Orion × Apex 1000. Fruit firmness of the remaining evaluated genotypes had different values of FF with significant differences among them. The hybrid Campbell 1327 VF × Scotia had medium FF values in the two seasons. Generally, most

Table 6. Fruit physical characters of tomato genotypes evaluated in the 1998/1999 and 1999/2000 winter seasons.

Genotype	Average fruit weight (g)		Fruit shape index		Fruit firmness (g/cm <sup>3</sup> )		Number of locules	
	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000
<b>Controls:</b>								
Alwadi (F <sub>1</sub> hybrid)	117.20 ab	115.20 abc	0.83ij	0.84 ghij	641.7 cdef	641.7 defg	4.5 cde	4.7 c
Supermarmande (true- breeding)	126.25 a	125.30 a	0.66l	0.65 m	465.0 ghi	465.0 lm	8.3 a	7.8 a
<b>Hybrids produced:</b>								
Apex 1000 × Campbell 1327 VF	67.20 fgh	60.20 hij	0.93 bcd	0.96 bcd	651.0 cdef	697.5 bcd	3.5 ghij	3.3 fgh
Apex 1000 × Oregon Spring V	65.80 fgh	64.50 ghij	0.90 defg	0.91 cdefg	725.4 c	716.1 bc	3.6 ghi	3.5 efg
Apex 1000 × Scotia	53.00 i	46.80 k	0.92 bcde	0.97 bc	697.5 cde	660.3 cdefg	3.2 hij	3.2 gh
Apex 1000 × Siletz	70.80 fgh	69.00 ghi	0.95 bc	0.96 bcd	1013.7 a	930.0 a	3.3 hij	3.3 fgh
Campbell 1327 VF × Oregon Spring V	116.30 abc	113.80 bcd	0.87 fghi	0.90 cdefgh	465.0 ij	437.1 m	5.0 c	5.0 c
Campbell 1327 VF × Scotia	108.10 bc	99.00 ef	0.95 bc	0.93 bcdef	641.7 cdef	604.5 fghi	4.0 efg	3.9 de
Campbell 1327 VF × Siletz	104.40 c	103.00 de	0.81 j	0.81 ijkl	409.2 j	399.9 m	6.1 b	6.1 b
Oregon Spring V × Siletz	122.30 a	112.00 cd	0.74 k	0.74 kl	567.3 fgh	567.3 hijk	6.3 b	6.3 b

*Continued*

Table 6. *Continued.*

Genotype	Average fruit weight (g)		Fruit shape index		Fruit firmness (g/cm <sup>3</sup> )		Number of locules	
	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000
Orion × Apex 1000	76.70 ef	71.00 gh	1.05 a	1.07 a	827.7 b	892.8 a	2.9 j	3.0 h
Orion × Campbell 1327 VF	63.10 hi	56.80 jk	0.95 bc	0.97 bc	716.1 c	753.3 b	3.3 hij	3.3 fgh
Orion × Oregon Spring V	62.50 hi	55.20 jk	0.96 b	1.00 ab	613.8 ef	595.2 ghij	3.1 ij	3.1 gh
Orlon × Scotia	60.80 hi	58.00 ijk	0.91 cdef	0.93 bcdef	623.1 def	623.1 efgh	3.4 ghij	3.3 fgh
Orion × Siletz	66.80 fgh	64.50 ghij	0.88 efgh	0.86 fghi	716.1 c	688.2 bcde	3.7 fghi	3.8 de
Scotia × Oregon Spring V	76.00 efg	74.80 g	0.89 defg	0.89 cdefghi	585.9 fg	548.7 ijk	3.5 ghij	3.7 def
Scotia × Siletz	90.80 d	88.50 f	0.81 j	0.82 hijk	446.4 ij	437.1 m	4.3 def	4.0 d
Supermarmande × Apex 1000	64.30 ghi	64.00 ghij	0.95 bc	0.95 bcde	725.4 c	678.9 cde	3.3 hij	3.2 gh
Supermarmande × Campbell 1327 VF	128.30 a	124.70 ab	0.76 k	0.76 jkl	706.8 cd	669.6 cdef	5.0 c	4.9 c
Supermarmande × Oregon Spring V	86.30 de	73.70 g	0.84 hij	0.84 ghij	492.9 hij	511.5 kl	4.8 cd	4.8 c
Supermarmande × Orion	63.70 hi	58.90 ij	0.86 ghi	0.87 efghi	706.8 cd	678.9 cde	3.8 fgh	3.8 de
Supermarmande × Scotia	67.00 fgh	65.00 ghij	0.88 efgh	0.88 defghi	576.6 fgh	558.0 hijk	3.4 ghij	3.2 gh
Supermarmande × Siletz	109.00 bc	105.50 cde	0.73 k	0.73 lm	585.9 fg	530.1 jkl	6.3 b	6.1 b
New LSD 0.05	12.24	11.33	0.05	0.09	87.42	69.75	0.7	0.46



Table 7. Fruit chemical constituents of tomato genotypes evaluated in the 1998/1999 and 1999/2000 winter seasons.

Genotype	TSS (%)		pH value		Titratable acidity (%)		Ascorbic acid content (mg/100 g fresh weight)	
	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000
<b>Controls:</b>								
Alwadi (F <sub>1</sub> hybrid)	5.7 cdef	5.4 fghij	4.42 a	4.42 ab	0.75	0.73 bcdef	8.6 e	10.1 defgh
Supermarmande (true – breeding)	5.7 cdef	5.3 ghij	4.28 abcde	4.29 abcdef	0.69	0.65 ef	8.7 e	9.4 fgh
<b>Hybrids produced:</b>								
Apex 1000 × Campbell 1327 VF	5.4 defg	5.1 ijk	4.37 ab	4.35 abcd	0.78	0.77 bcdef	8.7 e	9.4 fgh
Apex 1000 × Oregon Spring V	4.8 g	4.7 kl	4.36 abc	4.36 abc	0.53	0.56 f	9.8 cd	10.8 cde
Apex 1000 × Scotia	5.1 fg	5.0 jkl	4.35 abc	4.30 abcdef	0.63	0.64 ef	9.8 cd	11.1 cd
Apex 1000 × Siletz	5.8 bcdef	5.7 cdefg	4.28 abcde	4.28 abcdef	1.05	1.06 a	9.1 de	9.7 fgh
Campbell 1327 VF × Oregon Spring V	5.3 efg	5.0 jkl	4.16 bcde	4.17 abcdef	0.98	0.85 abcde	8.7 e	9.4 fgh
Campbell 1327 VF × Scotia	5.1 fg	5.1 ijk	4.24 abcde	4.24 abcdef	0.76	0.70 cdef	9.1 de	10.1 defgh
Campbell 1327 VF × Siletz	4.8 g	4.6 l	4.33 abc	4.31 abcdef	0.69	0.67 ef	8.7 e	9.1 h
Oregon Spring V × Siletz	5.4 defg	5.2 hij	4.04 e	4.02 f	1.01	0.98 ab	9.0 de	10.1 defgh

*Continued*

Table 7. *Continued.*

Genotype	TSS (%)		pH value		Titratable acidity (%)		Ascorbic acid content (mg / 100 g fresh weight)	
	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000
Orion × Apex 1000	5.3 efg	5.2 hij	4.22 abcde	4.21 abcdef	0.77	0.71 bcdef	8.6 e	9.2 gh
Orion × Campbell 1327 VF	5.8 bcdef	5.8 bcdef	4.44 a	4.43 a	0.65	0.65 ef	8.9 de	10.3 cdef
Orion × Oregon Spring V	6.1 abcd	6.0 abcd	4.07 de	4.05 def	0.77	0.77 bcdef	11.03 b	12.3 ab
Orion × Scotia	5.6 cdef	5.5 efghi	4.34 abc	4.34 abcde	0.74	0.72 bcdef	10.2 bc	11.3 bc
Orion × Siletz	6.0 abcde	6.2 ab	4.33 abc	4.32 abcdef	0.76	0.71 bcdef	9.4 cde	10.2 defg
Scotia × Oregon Spring V	5.7 cdef	5.6 defgh	4.22 abcde	4.23 abcdef	0.69	0.69 def	8.8 de	10.0 efgh
Scotia × Siletz	6.5 ab	6.4 a	4.34 abc	4.33 abcde	0.77	0.70 cdef	8.7 e	9.4 fgh
Supermarmande × Apex 1000	6.3 abc	6.2 ab	4.29 abcd	4.29 abcdef	0.81	0.78 bcdef	8.6 e	9.2 gh
Supermarmande × Campbell 1327 VF	5.5 defg	5.5 efghi	4.12 cde	4.12 bcdef	1.04	1.09 a	12.5 a	13.2 a
Supermarmande × Oregon Spring V	5.4 defg	5.2 hij	4.07 de	4.04 ef	0.93	0.75 bcdef	9.0 de	9.9 efgh
Supermarmande × Orion	6.7 a	6.2 ab	4.12 cde	4.11 cdef	1.01	0.96 abcd	8.9 de	9.3 fgh
Supermarmande × Scotia	5.7 cdef	5.9 bcde	4.17 bcde	4.17 abcdef	1.00	0.97 abc	9.6 cde	9.9 efgh
Supermarmande × Siletz	6.3 abc	6.1 abc	4.20 abcde	4.18 abcdef	0.98	0.98 ab	8.9 de	9.8 efgh
New LSD 0.05	0.74	0.46	0.25	0.31	NS	0.28	1.01	1.1

of the evaluated hybrids were superior to cv. Supermarmande (control) with respect to the FF values in the two seasons (Table 6). In the two seasons, fruits of cv. Supermarmande had the highest significant NL over all evaluated hybrids. It was followed by the hybrids Supermarmande × Siletz, Oregon Spring V × Siletz and Campbell 1327 VF × Siletz without significant differences among them. The hybrid Orion × Apex 1000 had the least NL/fruit. The hybrid Campbell 1327 VF × Scotia had fruits of medium NL which were 4.0 and 3.9 in the two seasons, respectively (Table 6).

The highest TSS values were detected in the hybrids Supermarmande × Orion and Scotia × Siletz in the first and second seasons, respectively. These two hybrids along with the hybrids Supermarmande × Apex 1000, Supermarmande × Siletz, Orion × Oregon Spring V and Orion × Siletz had the highest values of TSS over all evaluated genotypes without significant differences among them in the two seasons. They also surpassed the two controls in TSS values. The hybrid Campbell 1327 VF × Scotia had a moderate value of TSS, being 5.1% in the two seasons (Table 7). In the two seasons, the hybrid Orion × Campbell 1327 VF had the highest pH value over all evaluated genotypes, but without significant differences from most of them. The least pH value, in the two seasons, was detected in the hybrid Oregon Spring V × Siletz. The hybrid Campbell 1327 VF × Scotia had fruits of pH 4.24 in the two seasons (Table 7). In the first season, there were no significant differences in TA percentage among evaluated genotypes. In the second one, the hybrid Supermarmande × Campbell 1327 VF had the highest TA percentage over all the evaluated genotypes, but it was not significantly different from some other hybrids. The hybrid Apex 1000 × Oregon Spring V had the least TA percentage in the two seasons (Table 7). In the two seasons, The hybrid Supermarmande × Campbell 1327 VF had the highest AA content over all evaluated genotypes. In the first season, this hybrid was significantly different from all other genotypes evaluated, but in the second one it was not significantly different from the hybrid Orion × Oregon Spring V. The hybrids Alwadi and Campbell 1327 VF × Siletz had the lowest AA content in first and second seasons, respectively. In the two seasons, most evaluated hybrids were superior to cv. Supermarmande in AA content. Concerning the second control i.e., the hybrid Alwadi, all evaluated genotypes surpassed it in the first season, but in the second one it had medium AA content. The hybrid Campbell 1327 VF × Scotia had medium AA content in the two seasons compared with other genotypes evaluated.

In conclusion, the hybrids Campbell 1327 VF × Scotia and Supermarmande × Scotia were recommended for cultivation under low

tunnels. The first hybrid produced the highest values of percentage FS, TY and MY, but it was second in EY. It produced round fruits with an AFW about 100g having medium values of each of FF, NL, TSS, TA percentage and AA content. The second hybrid was second in TY and MY. It produced round fruits with an AFW about 66g having medium values of each of FF, NL and AA content. Fruit TSS was high, being 5.8.

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## إنتاج وتقييم بعض هجن الطماطم لزيارات الأفاق

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تم تقسيم ٥ أصنافاً من أصناف الطماطم صاندة لتربية كاباء محتملة لإنتاج الهجن بالإضافة إلى الهجين التجاري Alwadi أثناء الموسم الشتوى ١٩٩٧/١٩٩٨ تحت الأفاق باستخدام نظام الري بالتنقيط . أعطى الصنف Supermarmande أعلى القيم لكل من ارتفاع النبات والنسبة المئوية للعقد وعدد حبات الثمرة . أعطت الأصناف Scotia و Siberia و Oregon Spring V أعلى محصولاً مبكراً و الصنفين Siletz و Mountain Gold VFF أعلى محصولاً كلياً و الصنف Mountain Gold VFF أعلى محصول صالح للتسويق . أنتج الهجين Alwadi وكذلك الصنف Mountain Gold VFF أكبر الثمار وزناً . أظهرت ثمار الصنفين Apex 1000 و Mountain Gold VFF أعلى درجة من الصلابة . احتوت ثمار الصنف Burgess Stuffing على أعلى نسبة من المواد الصلبة الذائبة الكلية . احتوت ثمار الصنفين Long-Keeper و Apex1000 على أعلى نسبة من الحموضة المعيارية ، وكانت ثمار هجين Alwadi هي الأعلى - مغوياً - في فيتامين ج .

بناء على النتائج السابقة تم اختيار سبعة آباء لإنتاج ٢١ هجين في اتجاه واحد . قيمت هذه الهجن بالإضافة إلى استخدام هجين Alwadi و الصنف Supermarmande للمقارنة وذلك أثناء العروتين الشتويتين ١٩٩٨/١٩٩٩ و ١٩٩٩/٢٠٠٠ تحت الأفاق باستخدام نظام الري بالتنقيط .

يعتبر الهجينان Scotia × Campbell 1327 VF و Scotia × Supermarmande هما أفضل الهجن محل الدراسة حيث تفوقا في كلا الموسمين في بعض الصفات الاقتصادية الهامة . فقد حقق الهجين Scotia × Campbell 1327 VF أعلى القيم في كل من النسبة المئوية للعقد ، والمحصول الكلى ، والمحصول القابل للتسويق ، بينما كان الثانى في الترتيب في المحصول المبكر . وقد كان متوسط وزن الثمرة أكثر من ١٠٠ جرام في الموسم الأول ، و ٩٩ جرام في الموسم الثانى . تميزت ثمار هذا الهجين بأنها كروية الشكل وذات قيم متوسطة من حيث كل من الصلابة ، وعدد الحبات ، والمواد الصلبة الذائبة الكلية ، والنسبة المئوية للحموضة المعيارية ، ومحتوى الثمار من فيتامين ج . أما الهجين Scotia × Supermarmande فقد حقق المركز الثانى في كل من المحصول الكلى و المحصول الصالح للتسويق . وقد أنتج هذا الهجين ثماراً كروية الشكل متوسط وزنها ٦٦ جرام ذات قيم متوسطة من كل من الصلابة ، و عدد الحبات و محتوى الثمار من فيتامين ج ، بينما كان محتواها من المواد الصلبة الذائبة الكلية عالياً ( ٥,٨ % ) .

مجلة المؤتمر الثالث لتربية النباتات - الجيزة ٢٦ أبريل ٢٠٠٣

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