VG122
Breeding and agronomic evaluation of tomato cultivars for fresh market production in northern Victoria

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Agriculture Victoria

Know-how for Horticulture™

VG122

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1 a). Industry Summary

PROJECT AIM:

To improve tomato cultivars for fresh market production in northern Victoria.

Procedure

Breeding and field selection of improved fresh market tomato cultivars was undertaken in northern Victoria over three growing seasons (1991/92, 92/93 and 93/94) as part of an on-going program.

The breeding program aimed to develop an open-pollenated variety with similar field attributes to Arcadia, the local commercial standard, but with improved flavour and larger fruit. Parents were selected on the basis of field attributes under local management practices, fruit size and/or flavour. Several advanced families from earlier breeding work were also screened, along with commercial cultivars gathered from local seed companies. All screening and selection work was carried out under commercial management conditions which involve a ground production system, with buried drip irrigation and black plastic mulch on the beds.

The fruit and plant characteristics of all lines were visually rated in the field. For promising breeding lines and commercial cultivars, fruit firmness and flavour, measured as the concentration of sugars (soluble solids) and acidity, were measured in the laboratory. Replicated plantings were established in 1992/93 and 1993/94 to compare yields of promising breeding and commercial lines. Fruit from replicated plots was graded for size and marketability.

SUMMARISED OUTCOMES

- Advanced breeding line T8606 (FLORADADE X ARCADIA) identified, with similar field attributes to Arcadia, but better flavour. It was commercially released as AURORA in 1993.

- 89 successful crosses were made between 1991 and 1993. At least 15 show commercial promise beyond second generation.

- Approximately 40 commercial cultivars were screened under commercial conditions. Most are totally unsuited to local production requirements. Large vines, soft and/or misshapen fruit were common problems.

1 b). Technical Summary

Tomato production for fresh market is a thriving industry in northern Victoria, but relies heavily on the cultivar Arcadia, which was developed to meet local growing conditions and market requirements for fruit firmness. Arcadia has a strongly determinate bush type, and is consequently easy to hand-harvest. It is also early maturing, and due to its firmness, can be vine ripened. Despite its advantages, Arcadia has been criticised for lacking flavour and fruit size. As part of an on-going cultivar improvement program in fresh tomatoes, this project aimed to breed and/or select genotypes with stronger flavour and larger fruit size, and that were suited to local conditions and production practices.
The breeding program and results from field screening of both breeding lines and commercial cultivars during the 1991/92, 1992/93 and 1993/94 growing seasons are detailed in this report.

Field trials were established on the Institute of Sustainable Irrigated Agriculture at Tatura, at the nearby Dhurringile Prison Farm, and on commercial properties in major growing areas. Breeding lines and commercial cultivars were initially screened in observation plantings, from which promising lines were selected for more detailed evaluation in replicated trials. Field assessment consisted of a visual rating of vine and fruit characteristics (including vine habit, size and maturity; fruit size, shape, firmness and colour) for all lines. Fruit firmness, soluble solids and acidity were measured on commercial cultivars and replicated lines, and the latter were also picked to determine yield and fruit size distribution.

Breeding targeted both local growing and market requirements, with emphasis on improving flavour and increasing fruit size. Suitable true-breeding genotypes were identified through repeated field selection under commercial management conditions.
Several families of advanced breeding lines (to F7) were also screened, and the most promising selections were compared with commercial cultivars (including Arcadia) in the second and third seasons of the project. T8606 displayed similar field attributes to Arcadia, but consistently had stronger flavour which was reflected in higher fruit soluble solids concentrations. This line was commercially released as 'Aurora' in 1993.

During the course of the project, 89 successful crosses were made, and initial screening suggests commercial promise for at least 20 breeding families, including several F1 hybrids.

Commercial cultivars were found to be largely unsuited to local growing requirements, with the most common reasons being:

i) they develop a large and unmanagable vine
ii) fruit are too soft
iii) fruit are large, but have an ugly blossom-end scar (catface)

The fact that all cultivars were grown under management conditions tailored to suit Arcadia may have contributed to this result, but growers who tried the best of these cultivars and adjusted their irrigation and nutrition strategies reported similar problems.

2. Recommendations

(a) Extension/adoption by industry of research findings

It is recommended that commercial trials of Aurora continue. Although growers have reported minor difficulties in the production and handling of this cultivar, its flavour is consistently better than that of Arcadia, ensuring its success in some niche markets.

Promising advanced selections from the families T8601, T8606, T8804 and T8902 should be trialled under commercial growing conditions.

Further field selection is required before any of the newer breeding lines (1991-1993) can be identified for commercial release, although the prospect of releasing F1 hybrids needs to be further explored.

Apart from Arcadia and Aurora which were locally developed, no commercial cultivars can be recommended for production in northern Victoria. All cultivars tested showed inconsistent performance and problems with vine type and/or fruit quality.

(b) Directions for future research

Areas for further investigation are

i) commercial trial of advanced breeding lines (T8601, T8606, T8804, T8902)
ii) further field screening of T91, T92 and T93 families
iii) assess F1 hybrids for commercial adoption
iv) incorporate resistence to bacterial speck in future breeding programs
v) develop better management strategies for hybrid cultivars with vigorous vine types.

(c) Financial/commercial benefits of adoption of research findings

To remain competitive on domestic markets, tomato growers must be responsive to market requirements for quality and fruit type. Arcadia, the local industry standard, has been criticised in the markets, for lacking flavour and fruit size. While the firmness and other characteristics of this cultivar will ensure its popularity for some time to come, the fresh tomato industry in Northern Victoria, which has an annual farm-gate value approaching $20M and relies almost exclusively on Arcadia (>95%), would be unwise not to heed the market's comments. The development and adoption of cultivars with improved flavour and fruit size will assist the industry to expand its existing share of both domestic and export markets.

3. Technical Report

Background

Northern Victoria has traditionally been a major production area for fresh market tomatoes in Australia, with a warm dry climate, abundant irrigation water and proximity to major markets. Originally, growers produced "dual-purpose" tomatoes for both market and processing. During the 1970's and early 80's the industry declined dramatically due to an influx of tomatoes from Queensland onto domestic markets. Queensland fruit were more attractive and had longer shelf-life than the Victorian product. Queensland's success was largely due to the fact that American tomato cultivars (such as Floradade and similar cultivars developed in Florida) were ideally suited to growing conditions around Bundaberg and Bowen. These cultivars were bred for appearance and shelf-life, and rapidly became the standards for fresh market production in Australia. Attempts to grow 'Queensland' cultivars in northern Victoria generally met with limited success because of differences in climate and soil-type which led to poor yields and low fruit quality.

The Victorian Department of Agriculture initiated a small tomato breeding program in northern Victoria during the mid 1970's, and after extensive field testing, commercially released the cultivars Goulburn and Arcadia in 1985 and 1988 respectively. Both lines are well adapted to inland growing conditions, and have the appearance and shelf-life demanded by retailers. Arcadia has since come to dominate local production, comprising over 95% of current plantings, and continually fetches top prices in the markets. The adoption of Arcadia, together with improved growing techniques and a heightened awareness of quality assurance among growers, has led to a resurgence in fresh market tomato production in northern Victoria.

While the local industry continues to expand, with increasing demand on domestic markets and successful trial export shipments, it is important that work to develop and introduce better tomato cultivars be continued. Market requirements are always changing in response to consumer demands (such as the drive for better flavoured tomatoes). The genetic homogeneity of established cultivars declines gradually after release, so that productivity and fruit uniformity are reduced. For these reasons, new tomato lines must be found regularly if the long-term industry viability is to be maintained. Local screening trials have shown that although many new fresh market tomato cultivars are released overseas each year, few perform well under growing conditions of inland Australia. In addition to an annual program to screen newly imported lines, it is therefore necessary to breed improved tomato cultivars which meet market quality requirements, and are productive under local growing conditions.

This report describes activities in the first 3 years of an on-going program.

Materials and Methods

A plant breeding and field assessment program was conducted over three years (1991/92, 1992/93 and 1993/94) to develop and select superior phenotypes under local conditions, and to screen new commercial cultivars. Seasonal conditions were generally cool in all three years of the project, and heavy spring rains flooded trial plots in 1992/93 and 1993/94. Many of the breeding lines displayed susceptibility to bacterial speck (*Pseudomonas syringae*) which is favoured by wet conditions, and although regular copper sprays controlled this disease, the problem will need to be addressed in future breeding work. Despite adverse weather, good commercial yields were obtained from all major sites.

Commercial assessment was based on a ground production system involving 1.5 m wide beds, buried trickle irrigation and black plastic mulch. Tomatoes were planted in single rows with an in-row spacing of approximately 45 cm. Plants were visually rated in the field for productivity, bush type, managability and tolerance to diseases (principally bacterial speck - *Psuedomonas syringae*). Trials were located on control sites (Tatura and Dhurringile **[Plate 1]**), as well as on commercial properties in surrounding production areas. Breeding lines were planted in unreplicated plots, generally consisting of 25m of plant row, and were visually assessed at the time of selection. Commercial cultivars were also planted in observation plots which were visually assessed for plant and fruit characteristics. Fruit quality measurements were also made on commercial cultivars as detailed below. Promising breeding lines were compared with commercial standards in replicated plantings in some years. These trials were laid out as randomised blocks with four replicates, and were statistically analysed using Analysis of Variance procedures in Genstat 5 (Laws Agricultural Trust, Rothamsted Experimental Station).

Quantitative yield assessments were made on 2-metre sub-plots, which were harvested three times at 2-week intervals. Harvesting commenced when 5-10% of fruit reached "breaker" (incipient ripeness stage), and all fruit at or beyond this maturity stage were picked on each occasion. Harvested fruit were passed over a commercial grader which separated them into <30mm, 30-45mm, 45-60mm, 60-80mm and >80mm sizes. Marketable and unmarketable (based mainly on shape and the presence of blemishes and rots) fruit of each size were then weighed and counted separately.

Fruit for quality measurements were picked on the second harvest date, from outside the harvest plot to avoid bruising. Twelve market-quality fruit were picked at breaker maturity stage from each plot, and were then stored for 6 days at 20°C to achieve full colour development. For each fruit, fresh weight was measured, and then firmness was determined according to the methods of Sumeghy *et al.* (1983). The twelve fruit were divided into three groups of four, and were quartered lengthwise. One quarter of each fruit within a group was put through a commercial juice extractor, providing three extracts for soluble solids and acidity measurements (pH and titratable acidity as % citric acid). These were performed on the clear serum using the methods of Ruck (1956). All operations were carried out at room temperature.

Ruck, J.A. (1956) Chemical Methods for Analysis of Fruit and Vegetable Products.

Contribution 350, Chemistry Division, Canadian Dept. Ag.

Sumeghy, J.B., Huett, D.O., McGlasson, W.B., Kavanagh, E.E. and Nguyen. V.Q. (1983). Evaluation of fresh market tomatoes of the determinate type irrigated by trickle and grown on raised beds covered with polyethylene mulch. *Aust. J. Exp. Agric. Anim. Husb.* **23**, 325 - 330.

Results and Discussion

Breeding Lines

Breeding material was selected on the basis of proven suitability to local conditions, and/or one or more specific market attributes.

Local production is dominated by Arcadia, which develops a very compact vine and has exceptionally firm, uniform-green fruit which mature early, and can be vine-ripened. Growers find this cultivar very easy to grow, harvest and market. Pickers are able to harvest the fruit with minimal disturbance to the vine, and because it is so firm, the fruit can withstand grading and has a long retail shelflife. The combination of these attributes has made Arcadia extremely popular with growers as well as in the marketplace, and made it the benchmark cultivar against which new lines are judged. Field selection therefore favoured lines with a managable vine and firm, attractive fruit with a uniform green (no green shoulder) base colour. Within these constraints, lines with better flavour and larger fruit than Arcadia were sought. Parent material (Table 1) was selected for local adaptability and/or fruit size or flavour. Not surprisingly, many crosses included Arcadia or a closely related line.

The results of field selection trials conducted over the three seasons of this project are summarised in Table 2.

As well as the new crosses, lines from 1986, 1988 and 1989 were further developed and selected. A superior line of T8606 was multiplied and commercially released as Aurora in 1993/94. Aurora showed exceptional flavour in all trials, and has a managable vine with firm, attractive fruit [**Plates 2 and 3**]. Growers have shown an initial reluctance to adopt it however, because the vine is slightly larger than that of Arcadia, and the fruit are slightly softer and are reportedly more prone to skin damage. It is also slightly later maturing than Arcadia, and would therefore be best suited to mid- or late-season production. Commercial trials with this cultivar will continue.

The number of selections from advanced breeding lines of T8601, T8606 and T8615 reflect the promise of these families. T8606 in particular has stabilised with a genotype opitomised by Aurora. T8601 has many attributes in common with T8606, with individual selections for flavour and fruit size. T8615 shows high yield potential and has exceptionally firm fruit. It develops a much larger vine than Arcadia however, and fruit

commonly lack flavour. Segregants of T8804 and T8813 also show promise for fruit or vine type, but further selection is required before they can be considered for commercial release. T8902 combines Arcadia with an indeterminate Japanese tomato (Momotaro) which has exceptionally sweet flavour. Not surprisingly, progeny show huge variation in phenotype, but several selections have a compact vine type with a sweet flavoured fruit which is firmer than Momotaro, but retains the pink-red base colour. With further selection, such a cultivar could have application to both domestic and export markets.
In total, 89 crosses were successfully made during the course of this project (Table 2). Progeny from these crosses were generally still segregating in the field in the 1993/94 season, but the number of F2 and F3 selections made from the 1991 and 1992 crosses respectively, reflect their promise. The F1 progeny of T9301, T9320, T9321, T9323 and T9334 also attracted great interest among growers in the 1993/94 season, suggesting the future potential for development of hybrid cultivars as a part of this program.

Replicated Trials

Replicated plantings of selected breeding and commercial lines were established during the 1992/93 and 1993/94 seasons, to provide statistical comparisons of their relative performance.

In 1992/93, replicated plantings were established at Dhurringile, Lancaster, Harston and Murchison. Six lines were evaluated, including two selections of Arcadia (the original and a "large fruited" commercial selection - LFS) and Tornado, a commercial cultivar from South Pacific Seeds which showed promise in earlier observation trials (Table 5). Data from all sites were combined for analysis (Table 3), and showed that Tornado produced a higher yield, and had larger fruit than either of the Arcadia selections, or the advanced breeding lines. Tornado also produced a much larger vine than the other lines, and was therefore unpopular with growers. Many of the larger Tornado fruit were misshapen, and had a large, ugly blossom-end scar (also known as fasciation or catface), which would reduce their quality (to second grade) or render them unmarketable. There were few significant differences between the Arcadia selections and the breeding lines, although both T8606 (Aurora) and T8601 had better flavour as measured by Soluble Solids concentration. There were no significant differences between the two Arcadia selections.

Two replicated trials were planted in 1993, and results from them were analysed separately (Table 4). Four commercial (Arcadia, Aurora, Red Bay and Tornado) and three breeding lines (T8606 - a sister line to Aurora, T8601 and T8615) were planted. Fruit from these trials were more stringently graded for unmarketability than in the previous season, and the tendency for the commercial cultivars (Red Bay and Tornado) to produce rough fruit was clearly evident. The high percentage of reject fruit (>30%) in both commercial lines was also reflected in relatively low marketable yields. The commercial cultivars also produced more large fruit than either Arcadia, Aurora or any of the breeding lines. The ranking of entries with respect to marketable fruit yield varied between sites, but Arcadia performed well at both locations. Differences in firmness and solids were generally non-significant, but Arcadia and T8606 were firmest, and Arcadia

had the lowest soluble solids at both sites.

Overall, the replicated trials showed that the local breeding lines were agronomically better suited to local production systems than the commercial cultivars. Arcadia produced good yields of firm fruit at all sites, justifying its local popularity. The breeding lines (T8606/Aurora, T8601 and T8615) were not as consistently productive as Arcadia, but matched it in the first season (Table 3). In terms of fruit quality, the breeding lines tended to be firmer than the commercials, and Arcadia had lower soluble solids than most other entries. It should be noted, that as part of commercial crops, most of these trials were managed to suit the growth and maturity pattern of Arcadia. This could be expected to disadvantage the commercial cultivars in particular, because they have a lower recommended nitrogen requirement than Arcadia. Small commercial plantings of cultivars such as Tornado were established by several growers during the course of the project, and were managed separately and according to recommendations. Reports from these growers indicated that they had experienced similar fruit quality problems to those seen in our trials.

Commercial Cultivars

Fresh market cultivars, submitted by commercial seed companies, were planted in observation trials in each year of the project. No yields were taken, but agronomic characteristics were rated and fruit quality aspects were measured (Tables 5, 6 and 7).
While many had good flavour and large fruit, most of the commercial cultivars trialled produced a vine that was too big to suit local production practices. Soft fruit, cracking and ugly shape (often due to a large blossom-end scar), were other common problems. Solar Set, Shady Lady, Tornado, Sundance, Regency, Red Bay and Triumph have all shown some commercial promise. Growers are understandably unwilling to adopt new cultivars which are more difficult to manage in the field, while the market continues to pay high prices for good quality Arcadia fruit - despite its lack of flavour and size.
For this reason Triumph, a hybrid with Arcadia parentage, was developed specifically to compete with Arcadia. Triumph is currently undergoing commercial trials.

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APPENDIX 1

PLATES (3) AND TABLES (7)

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TABLE 1

PARENT MATERIAL USED IN FRESH MARKET TOMATO BREEDING PROGRAM 1991-1993.

LINE	PARENTS
1986	
T 8601	C 33 X ARCADIA
T 8606	FLORADADE X ARCADIA
T 8613	C 33 X GOULBURN
T 8615	C 33 X SUNNY (F2)
1988	
T 8801	ARCADIA X T 8601.1.1
T 8804	VF 53 X ARCADIA
T 8807	GOULBURN X T 8601.1.1
T 8808	VF 53 X GOULBURN
T 8809	VF 53 X T 8601.1.1
T 8812	T 8601.1.1 X VF 53
T 8813	T 8601.1.1 X T 8613.1.2
1989	
T 8902	ARCADIA X MOMOTARO
1991	
T 9101	T 8606.1.1 X ARCADIA LFS
T 9102	K 7411 X SUMMERTASTE
T 9103	T 8606.2.1 X LONG LIFE
T 9104	ARCADIA SWEET X ES 58
T 9105	ARCADIA LFS X LONGLIFE
T 9106	ARCADIA LFS X CELEBRITY

T 9107	CELEBRITY X ARCADIA LFS
T 9108	T 8601.1.1. X SOLAR SET
T 9109	ARCADIA LFS X RED MOUNTAIN
T 9110	CELEBRITY X ARCADIA SWEET
T 9111	T 8606.2.1 X CELEBRITY
T 9112	ARCADIA SWEET X RED MOUNTRAIN
T 9113	T 8606.1.1 X SUMMERTASTE
T 9114	ARCADIA SWEET X LONGLIFE
T 9115	T 8606.1.1 X CELEBRITY
T 9116	ARCADIA SWEET X CELEBRITY
T 9117	ES 58 X T 8606.2.1
T 9118	ARCADIA LFS X SOLARSET
T 9119	ARCADIA SWEET X SUMMERTASTE
T 9120	K 7411 X CELEBRITY
T 9121	ARCADIA SWEET X SOLARSET
T 9122	ARCADIA LFS X SUMMERTASTE
T 9123	K 7411 X LONGLIFE
T 9124	K 7411 X RED MOUNTAIN
T 9125	T 8606.2.1 X SUMMERTASTE
T 9126	BR 54 (F2)
T 9127	SUMMERTASTE X ARCADIA LFS
1992	
T 9201	AURORA X TRISTAR
T 9202	TRISTAR X AURORA
T 9203	AURORA X TORNADO
T 9204	AURORA X FIREFOX
T 9205	FIREFOX X AURORA
T 9206	TRISTAR X AURORA
T 9207	TORNADO X AURORA
T 9208	AURORA X ARCADIA
T 9209	TORNADO X AURORA

T 9210	TORNADO X AURORA
T 9211	FIREFOX X AURORA
T 9212	FIREFOX X AURORA
T 9213	FIREFOX X AURORA
T 9214	ARCADIA X AURORA
T 9215	ARCADIA X AURORA
T 9216	ARCADIA X TRISTAR
T 9217	ARCADIA X TORNADO
T 9218	ARCADIA X FIREFOX

1993

T 9301	ARCADIA X K 7
T 9302	ARCADIA X BURNLEY METRO
T 9303	ARCADIA X SHASTA
T 9304	ARCADIA X BR 84
T 9305	ARCADIA LFS X BURNLEY METRO
T 9306	ARCADIA LFS X BURNLEY GEM
T 9307	BR 84 X SHASTA
T 9308	BR 84 X H 2009
T 9309	H 2009 X AURORA
T 9310	BR 84 X ARCADIA
T 9311	BR 84 X K 7
T 9312	BURNLEY GEM X K 7
T 9313	T 8606.1.1.1.4.4.MSDX BR 84
T 9314	ARCADIA LFS X SHASTA
T 9315	BR 84 X BURNLEY METRO
T 9316	ARCADIA X BURNLEY GEM
T 9317	T 8606.1.1.1.4.4.MSDX ARCADIA
T 9318	T 8606.1.1.1.4.4.MSDX K 7
T 9319	H 2009 X T 8606.1.1.1.4.4.MSD
T 9320	ARCADIA LFS X K 7

T 9321	K 7 X AURORA
T 9322	BURNLEY GEM X BR 84
T 9323	K 7 X ARCADIA
T 9324	ARCADIA LFS X BR 84
T 9325	T 8606.1.1.1.4.4.MSDX SHASTA
T 9326	BURNLEY GEM X AURORA
T 9327	T 8606.1.1.1.4.4.MSDX BURNLEY METRO
T 9328	ARCADIA X H 2009
T 9329	ARCADIA LFS X H 2009
T 9330	ARCADIA X KY 1
T 9331	ARCADIA X AURORA
T 9332	BURNLEY GEM X ARCADIA
T 9333	KY 1 X AURORA
T 9334	ARCADIA X H 2009
T 9335	ARCADIA X AURORA
T 9336	ARCADIA X KY 1
T 9337	AURORA X BURNLEY METRO
T 9338	ARCADIA X H 2009
T 9339	AURORA X BURNLEY GEM
T 9340	AURORA X K 7
T 9341	T 8606.1.1.1.4.4.MSDX BR 84
T 9342	T 8606.1.1.1.4.4.MSDX BURNLEY GEM
T 9343	AURORA X T 8606.1.1.1.4.4.MSD
T 9344	ARCADIA X T 860o.1.1.1.4.4.MSD
T 9345	BR 84 X AURORA
T 9346	AURORA X K 7
T 9347	KY 1 X AURORA
T 9348	AURORA X BURNLEY METRO
T 9349	ARCADIA LFS X KY 1

TABLE 2

TOMATO BREEDING PROGRAM SUMMARY - 1991/92 TO 1993/94

KEY

F = Generation
P = Number of lines planted
S = Number of selections
[Single or Multiple (MS) plant selections]

SITES:

D = H.M.P. Dhurringile
T = I.S.I.A Tatura

CUM = R Cumming	Bridgewater
FER = M Ferrari	Cobram
FID = A Fideli	Swan Hill
MER = T Mercuri	Byrneside
MON = J Monigatti	Echuca
SCA = R Scarpari	Ardmona
SCR = P Scrimizzi	Harston
VRA = J Vraca	Murchison

LINE	1991/92				1992/93				1993/94				GENERAL REMARKS
	F	SITE	P	S	F	SITE	P	S	F	SITE	P	S	
T8601	4	D	1	1	5	D	1	0					
	4	T	1	0									
	6	D	12	6	7	D	5	7	8	T	2MS	1MS	
									8	VRA	1+2MS	0	
	7	D	51	32+1MS	8	D	20	18+1MS	9	D	1MS	0	
									9	T	2+1MS	2MS	Compact bushes, rolled leaves.
									9	CUM	1MS	0	Fruit firm but some variation in size - small fruit in some selections.
									9	FER	1MS	0	
									9	FID	1MS	0	Some rough shapes, and unattractive colour in early generations.
									9	MER	1MS	0	
									9	MON	1MS	0	
									9	SCR	1MS	0	
									9	VRA	3+4MS	2MS	
	7	T	3	2	8	D	1	2					
	7	CUM	1	0									
	7	FER	1	1	8	D	1	0					
	7	MER	1	0									
	7	SCR	1	0									
	7	TAV	1	0									
	7	VRA	1	0									

									4	T	1	0	
									5	T			
									6	T	7	0	
T8606	4	D	1	1	5	D	1	0					
					5	T	1	1					
					5	CUM	1	1					
					5	FER	1	0					
					5	SCA	1	0					
	4	T	2	0									
	7	D	29	29+4MS	8	D	19+8MS	41+1MS	9	D	3+1MS	1MS	
									9	T	5+2MS	1+4MS	
									9	CUM	1+1MS	0	
									9	FER	1+1MS	0	
									9	FID	1+1MS	0	
									9	MER	1MS	0	
									9	MON	1+1MS	0	
									9	SCR	1+1MS	0	
									9	VRA	8+4MS	1+5MS	
					8	T	5+2MS	4+1MS	9	T	1+1MS	0	
									9	VRA	1+1MS	0	
					8	CUM	5+2MS	2+1MS	9	VRA	1MS	0	
					8	FER	5+2MS	0					

Medium-compact vine.

Fruit of variable shape and size,
- some rough and ribbed, and also some cracking.

Many with very good colour.

Flavour variable - generally average.

					8	MER	2MS	0					
					8	SCA	5+2MS	2	9	T	1	0	
									9	VRA	1	0	
					8	SCR	2MS	0					
					8	VRA	2MS	3	9	D	1	0	
	7	T	7	9+3MS	8	D	9+3MS	26	9	T	1+3MS	1MS	
									9	VRA	3+4MS	1+1MS	
	7	CUM	5	0									
	7	FER	5	3	8	D	3	0					
	7	MER	5	0									
	7	SCR	5	3MS	8	D	3MS	17	9	VRA	3MS	0	
	7	TAV	5	0									
	7	VRA	5	1MS									
T8613	4	D	2	0									Medium-large vine, mid-season maturing, variable flavour and some green shoulders. Round fruit, but variable size and shape.
	4	T	2	0									
T8615	4	D	2	2									
	4	T	1	0									
	7	D	14	17+1MS	8	D	17+1MS	24+1MS	9	D	1MS	0	Medium-compact vine with rolled leaves.
									9	T	2MS	0	
									9	CUM	1MS	0	Fruit medium firm, with some
									9	FER	1MS	0	mealiness and poor internal colour
									9	FID	1MS	0	Some small fruit.

									9	MER	1MS	0	
									9	MON	1MS	0	Flavour lacking in some selections,
									9	SCR	1MS	0	but good yields.
									9	VRA	2+4MS	2MS	
					8	MER	1	0					
					8	SCR	1	0					
					8	VRA	1	0					
	7	T	1	1MS	8	D	1MS	0					
	7	CUM	1	0									
	7	FER	1	0									
	7	MER	1	0									
	7	SCR	1	0									
	7	TAV	1	0									
	7	VRA	1	0									
T8801	4	D	3	4	5	D	4	1	6	T	1	0	Medium vine, round-flat/round fruit.
									6	VRA	1	0	Mid season. Flavour OK.
T8804	4	D	8	13	5	D	13	34	6	T	3+1MS	0	
									6	CUM	1MS	0	
									6	FER	1MS	0	Good, compact vine.
									6	FID	1MS	0	Firm, small-medium sized fruit.
									6	MON	1MS	0	Some pointed.
									6	SCR	1MS	0	Flavour OK, but some meally texture.

									6	VRA	4+5MS	1+1MS	
T8807	4	D	2	0									Medium/erect vine. Ugly blossom scar (BES).
T8808	4	D	2	0									Medium vine, very rough fruit (ugly BES).
T8809	4	D	1	0									Large vine, late maturing. Fruit large, with green shoulder.
T8812	4	D	2	0									Medium spreading vine, uniform green fruit.
T8813	4	D	15	6	5	D	6	3	6	VRA	2	0	Compact-medium vine, attractive uniform green fruit but poor flavour. Also small
T8902	3	D	1	0									Segregation in habit, strong flavour (sweet).
					3	D	1MS	3	4	VRA	2	9	Globe fruit, some green shoulder/Momotaro.
T9101	1	T	1	1MS	2	D	1	7	3	VRA	6	1+1MS	Medium vine. Firm fruit with acid flavour. Some cracking. Small-medium fruit.
T9102	1	T	1	1MS	2	D	1	0					Indeterminate vine, fruit large but lacking flavour. Rather soft.
T9103	1	T	1	1MS	2	D	1	4					Large vine, segregating for most fruit characteristics. Good size and flavour but some cracking.
T9104	1	T	1	1MS	2	D	1	1MS	3	VRA	1MS	0	Large vine, late maturing.
T9105	1	T	1	1MS	2	D	1	0					Segregating for most fruit characteristics. Large vine and fruit. Green shoulder.
T9106	1	T	1	1MS	2	D	1	0					Large vine, green shoulder.
T9107	1	T	1	1MS	2	D	1	1+1MS	3	VRA	1+1MS	0	Wide variation in fruit shape and colour. Large vine.
T9108	1	T	1	1MS	2	D	1	2	3	VRA	2	0	Medium-large vine, late maturing. Sweet flavour.
T9109	1	T	1	1MS	2	D	1	0					Medium-large vine, small medium fruit, variable shape.

T9110	1	T	1	1MS	2	D	1	0					Medium-large vine, small fruit although sweet flavoured.
T9111	1	T	1	1MS	2	D	1	1	3	VRA	1	0	Medium-large vine, late maturing, small fruit, soft.
T9112	1	T	1	1MS	2	D	1	2	3	VRA	2	3	Medium-large vine, medium fruit, some green shoulder, very firm.
T9113	1	T	1	1MS	2	D	1	0					Large vine and fruit.
T9114	1	T	1	1MS	2	D	1	3	3	VRA	3	4	Medium-large vine, some fruit rather soft, medium size.
T9115	1	T	1	1MS	2	D	1	1					Large vine, green shoulder.
T9116	1	T	1	1MS	2	D	1	4	3	VRA	4	1	Large vine, some green shoulder.
T9117	1	T	1	1MS	2	D	1	4	3	VRA	4	10	Large vine, fruit large but some soft. Late.
T9118	1	T	1	1MS	2	D	1	1	3	VRA	1	1	Medium-large vine. Soft fruit, poor flavour, late maturing.
T9119	1	T	1	1MS	2	D	1	0					Large vine, some green shoulder, poor flavour, soft.
T9120	1	T	1	1MS	2	D	1	2	3	VRA	2	0	Large vine, some pointy fruit, acid flavour.
T9121	1	T	1	1MS	2	D	1	0					Large vine, soft fruit, green shoulder.
T9122	1	T	1	1MS	2	D	1	2	3	VRA	2	0	Very large vine, late maturing, soft, green shoulder.
T9123	1	T	1	1MS	2	D	1	0					Large vine, fruit soft, green shoulder.
T9124	1	T	1	1MS	2	D	1	0					Green shoulder.
T9125	1	T	1	1MS	2	D	1	1	3	VRA	1	0	Compact vine, small fruit, some green shoulder.
T9126	1	T	1	1MS	2	D	1	1					Medium-compact vine, green shoulder, bit soft.
T9127	1	T	1	1MS	2	D	1	0					Medium-large vine, small fruit, dark green shoulder.

T9201					1	D	1	1MS	2	D	1	1MS	Yellow fruit, very firm, medium vine, sour flavour, very late.
T9202					1	D	1	1MS	2	D	1	4	Medium vine, some soft fruit, splitting
T9203					1	D	1	1MS	2	D	1	7	Medium-small vine, some splitting.
T9204					1	D	1	1MS	2	D	1	6	Medium-large vine, very large fruit, some rough, variable firmness.
T9205					1	D	1	1MS	2	D	1	2	Medium-large vine, some small fruit, splitting, late, many soft.
T9206					1	D	1	1MS					Non-viable seed
T9207					1	D	1	1MS	2	D	1	3	Medium vine, some green shoulder, variable firmness, good flavour.
T9208					1	D	1	1MS	2	D	1	9	Medium vine, late, good colour, some small, rolled leaves.
T9209					1	D	1	1MS	2	D	1	2	Medium vine, late, some green shoulder, concentric cracking.
T9210					1	D	1	1MS					Non-viable seed
T9211					1	D	1	1MS					Non-viable seed
T9212					1	D	1	1MS	2	D	1	3	Medium vine, large fruit, good flavour, variable firmness.
T9213					1	D	1	1MS	2	D	1	0	Medium vine, rolled leaves, good colour and flavour.
T9214					1	D	1	1MS	2	D	1	4	Compact vine, firm fruit, flavour OK.
T9215					1	D	1	1MS	2	D	1	3	Medium compact vine, rolled leaves, good yield, lacks flavour.
T9216					1	D	1	1MS	2	D	1	1	
T9217					1	D	1	1MS	2	D	1	1	Medium vine, good size, green shoulder, bit soft, lacks flavour.

T9218					1	D	1	1MS	2	D	1	2	Medium vine, round fruit, some soft, lacks flavour.
T9301									1	MER	1	1MS	Large, dense vine. Attractive fruit, good size.
T9302									1	MER	1	1MS	Large vine. Fruit green shouldered and small.
T9303									1	MER	1	1MS	Medium vine. Small fruit, bad bacterial speck.
T9304									1	MER	1	1	Single plant. Fruit with green shoulder.
T9305									1	MER	1	1MS	Medium vine. Fruit small, green shouldered and a bit soft.
T9306									1	MER	1	1MS	Compact vine. Strong green shoulder, soft.
T9307									1	MER	1	1MS	Medium vine. Fruit size OK, some green shoulder.
T9308									1	MER	1	1MS	Medium vine, many ugly fruit (BES).
T9309									1	MER	1	1MS	Compact vine. Good size and flavour, but some bacterial speck damage.
T9310									1	MER	1	1MS	Tall vine. Some speck damage.
T9311									1	MER	1	1MS	Large vine. Good fruit size, no speck. Some green shoulder.
T9312									1	MER	1	1MS	Large vine and fruit. Soft and with green shoulder.
T9313									1	MER	1	1MS	Large vine. Good fruit shape but some green shoulder.
T9314									1	MER	1	1MS	Compact vine, but small fruit and some with green shoulder.
T9315									1	MER	1	1MS	Tall vine. Fruit soft with green shoulder.
T9316									1	MER	1	1MS	Compact vine. Fruit soft with green shoulder.

T9317									1	MER	1	1MS	Compact vine. Firm but pointed fruit.
T9318									1	MER	1	1MS	Large vine. Small fruit, with some green shoulder.
T9319									1	MER	1	1MS	Compact vine. Bacterial speck damage. Early.
T9320									1	MER	1	1MS	Compact vine. Good fruit.
T9321									1	MER	1	1MS	Compact vine. Good fruit.
T9322									1	MER	1	1MS	Large vines. Late maturing. Green shoulder.
T9323									1	MER	1	1MS	Medium vine. Good yield, some speck.
T9324									1	MER	1	1MS	Medium vine. Some green shoulder. Poor flavour.
T9325									1	MER	1	1MS	Large vine, small fruit with some green shoulder.
T9326									1	MER	1	1MS	Medium vine, good flavour and size. Green shoulder.
T9327									1	MER	1	1MS	Tall vine. Good flavour but fruit small and green shouldered.
T9328									1	MER	1	1MS	Compact vine. Fruit OK.
T9329									1	MER	1	1MS	Very compact vine with speck damage. Fruit very firm but with poor flavour.
T9330									1	MER	1	1MS	Tall vines. Very poor flavour.
T9331									1	MER	1	1MS	Compact vines. Very good yield, fruit shape and size. Poor flavour.
T9332									1	MER	1	1MS	Compact vines. Good flavour but soft.
T9333									1	MER	1	1MS	Tall vines. Good flavour but soft.
T9334									1	MER	1	1MS	Compact vines. Very firm fruit and good yield.

T9335									1	MER	1	1MS	Medium-compact vines. Fruit OK.
T9336									1	MER	1	1MS	Tall vines. Green shoulder, poor flavour.
T9337									1	T	1	1MS	.
T9339									1	T	1	1MS	.
T9340									1	T	1	1MS	.
T9341									1	T	1	1MS	.
T9342									1	T	1	1MS	.
T9343									1	T	1	1MS	. LATE PLANTED - NOTES NOT TAKEN . BECAUSE OF POOR PLANT GROWTH.
T9344									1	T	1	1MS	.
T9345									1	T	1	1MS	.
T9347									1	T	1	1MS	.
T9348									1	T	1	1MS	.
T9349									1	T	1	1MS	.
K7411	2	D	1	1+1MS	3	D	1+1MS	1MS	4	VRA	1	1MS	
	2	CUM	1	0									
	2	FER	1	0									Medium-compact vine.
	2	MER	1	0									Fruit firm but some rough and ribbed.
	2	SCR	1	0									Also lacks size.
	2	TAV	1	0									
	2	VRA	1	0									
K7712	6	D	5	0									Arcadia breeding line

TABLE 3: Combined yield and fruit quality results for replicated fresh market trials at four sites (Dhurringile, Murchison, Harston and Lancaster) in season 1992/93

TREATMENT	TOTAL YIELD (T/Ha)	SIZE DISTRIBUTION - % BY WEIGHT (mm DIAMETER)					FRUIT QUALITY ASSESSMENT			
		<30	30-45	45-60	60-80	>80	FIRM*	pH	TA (%cit)	SS (%)
TORNADO	110	-	0.6	10.5	53.6	35.4	1.51	3.93	0.38	4.7
T8601	94	0.1	1.9	41.0	50.4	6.7	1.30	3.80	0.50	4.8
T8615	94	-	0.9	37.6	58.0	3.5	1.39	3.83	0.47	4.4
T8606	94	0.1	1.1	31.8	60.8	6.3	1.33	3.83	0.48	4.8
ARCADIA LFS	92	0.1	0.8	36.6	59.5	3.1	1.40	3.83	0.47	4.5
ARCADIA	92	0.1	0.8	40.8	56.7	1.7	1.33	3.82	0.49	4.5
LSD_{05}	14.1	0.1	1.0	12.1	17.2	9.2	0.24	0.07	0.05	0.2

* Firmness measured as mm compression. The larger the value, the softer the fruit.

TABLE 4: REPLICATED FRESH MARKET TRIALS: 1993/4

SITE 1: J. VRACA, MURCHISON.

Transplanted: 8/10/93 Harvested: 23/1,7/2,18/2/94

CULTIVAR	TOTAL MARKET YIELD	Size Distribution and Unmarketable (%)						FIRM (mm)	SS (%)
		<30mm	30-45	45-60	60-80	>80mm	Unmk		
T8615	103.0	0.5	47.1	21.4	30.9	0.2	14.9	1.66	4.43
ARCADIA	85.5	1.5	43.3	14.9	39.3	1.0	18.1	1.32	4.40
T8601	72.6	1.1	46.9	17.2	34.9	0.0	19.8	1.53	4.53
AURORA	70.9	2.3	40.5	21.0	31.9	4.3	23.6	1.53	4.43
T8606	70.9	4.4	43.6	18.6	32.7	0.7	21.4	1.31	4.58
RED BAY	70.6	1.3	12.7	11.4	45.3	29.3	40.4	1.80	4.70
TORNADO	68.3	0.0	26.8	13.9	44.4	14.9	35.6	1.61	4.85
LSD_{05}	8.8	7.4	22.4	10.1	18.1	11.0	11.9	0.28	0.33

SITE 2: T. MERCURI, BYRNESIDE.

Transplanted: 23/09/93 Harvested: 19/1,3/2,17/2/94

ARCADIA	136.0	0.1	24.4	17.9	52.2	5.0	16.4	1.03	3.93
T8606	118.8	0.0	23.9	20.5	54.3	1.4	17.1	1.01	4.63
T8601	110.0	0.6	27.5	14.7	57.0	0.3	19.7	1.19	4.20
T8615	109.0	0.2	32.5	24.9	42.3	0.0	21.1	1.26	4.03
AURORA	105.5	0.4	25.7	18.1	50.4	5.4	19.9	1.55	4.40
RED BAY	82.0	0.7	7.3	3.6	60.4	28.0	32.5	1.64	4.28
TORNADO	73.0	0.6	13.1	14.6	53.4	18.3	38.2	1.10	4.33
LSD_{05}	6.4	0.7	7.8	10.2	14.9	12.2	7.1	0.60	0.27

TABLE 5: Results from Fruit Quality Measurements on Commercial Cultivars at Dhurringile (1991/92)

CULTIVAR	FRUIT WT (g)	FIRM (mm comp.)	pH	T.A. (% Cit.)	S.S (%)	Critical Comments
Arcadia	139	1.48	4.05	0.39	4.3	Acid flavour
Arcadia Large	160	1.38	4.01	0.46	3.8	Mealy texture
Arcadia Sweet	133	1.52	3.90	0.47	3.8	Cracking
Goulburn	167	1.35	4.17	0.35	3.7	Hollow fruit
Aurora	163	1.47	4.09	0.46	4.5	Some cracks
K7411	119	1.63	3.99	0.43	4.6	Variable size
VF 53	203	2.10	4.11	0.41	4.9	Large vine
C33	172	2.00	4.05	0.44	4.2	Soft
Floradade	173	1.60	3.97	0.56	4.5	Large vine
Tristar	202	1.34	4.23	0.34	4.7	Cracking
Crossfire	250	1.91	4.04	0.44	5.2	Variable size
Jy 361	273	2.33	4.04	0.43	4.7	Open vine, soft
Regency	160	1.79	4.00	0.46	5.0	Ugly blossom-end
Solar Set	194	1.57	4.03	0.40	4.7	
Venus	235	1.49	4.11	0.42	4.9	Fruit too big?
Shady Lady	216	1.53	4.05	0.39	4.3	
Red Centre	173	1.28	3.93	0.46	3.5	Large vine
Red Mt.	210	1.68	3.96	0.55	5.1	Open vine
Red Bay	217	1.54	4.02	0.43	4.1	Cracking
BR 84	278	1.08	4.07	0.50	4.9	Large vine
FTA 3	212	1.38	4.04	0.40	4.5	Cracking
Tornado	237	1.31	4.03	0.38	4.2	
Continental	224	168	3.95	0.45	4.6	Cracking
Firefox	295	1.45	3.98	0.50	4.8	Large vine
Sundance	164	1.64	3.98	0.52	5.0	
Redback	238	1.37	3.98	0.44	4.3	Variable shape
TA 399	222	1.94	3.99	0.43	3.8	Open vine
TA 400	263	1.28	4.05	0.39	4.8	Fruit too big
TA 537	213	1.43	4.03	0.46	4.1	Cracking

TABLE 6: Results from fruit quality measurements on commercial fresh market tomato cultivars at Dhurringile (1992/93)

CULTIVAR	FRUIT WT (g)	FIRM. (mm comp.)	pH	TA (%CT)	SS (%)	COMMENT
A 701	125	1.40	3.65	0.68	4.8	Compact vine, small fruit, GS
GOULBURN	106	1.32	3.87	0.37	4.4	Medium vine, very firm, lacks flavour
VENUS	219	1.31	3.85	0.45	5.0	Large vine, lacks flavour, GS
TORNADO	151	1.48	3.79	0.46	4.6	Large vine, rough fruit, GS
AURORA (T8606)	109	1.42	3.71	0.50	4.9	Good vine and fruit
PATRIOT	153	1.44	3.77	0.41	4.7	Medium vine, large fruit, rough, GS.
REGENCY	158	1.40	3.89	0.35	4.8	Medium vine, large calyx scar, GS
ZOLA	128	1.95	3.73	0.49	4.3	Medium vine, sour flavour
TRISTAR	156	1.54	3.74	0.45	4.7	Large vine, rough fruit, GS
FDA 3	172	1.50	3.74	0.54	4.7	Medium vine, lacks flavour, GS
NKX 649	143	1.65	3.7	0.45	3.8	Large vine, GS, lot of big bud
RED BAY	174	1.25	3.75	0.51	5.1	Medium vine, GS, large scars
SHADY LADY	140	1.91	3.81	0.48	5.0	Large vine, fruit soft
DELTA DAWN	154	1.22	3.69	0.52	4.6	Medium vine, large fruit, GS
NW 206	159	1.57	3.74	0.47	4.9	Large vine, late maturing, GS
SPS 3	214	1.17	3.85	0.38	4.7	Large vine and fruit
SPS 4	183	1.55	3.86	0.50	5.0	Large vine, acid flavour
SPS 6	200	1.25	3.87	0.49	5.0	Large vine, bit soft
SPS 7	174	1.68	3.94	0.41	4.9	Large vine, GS, sweet flavour
SPS 9	166	1.30	3.89	0.39	4.9	Compact vine, fruit soft, GS

NOTE: GS = Dark green shoulder on mature-green fruit

TABLE 7: Quality of commercial cultivars from Murchison observation trial (1993/4)

CULTIVAR	FRUIT WEIGHT (g)	FIRMNESS (mm comp)	SOLUBLE SOLIDS (%)	pH	COMMENTS
Arcadia LFS	130.2	0.70	4.9	4.11	Compact vine, firm fruit
Arcadia	120.8	1.19	4.6	4.10	Compact vine, firm fruit
Aurora	141.6	1.54	4.6	4.12	Medium vine, good flavour
Bermuda	190.8	1.51	4.4	4.31	Large vine. Good flavour and semi-ripe colour
Champion	207.9	1.42	4.3	4.11	Medium-large vine, hard to pick, large fruit.
Delta Dawn	207.8	1.38	4.4	4.16	Large vine and fruit, some rough shapes, GS
Eagle	194.8	1.82	4.8	4.13	Large vine, GS
Hawk	157.4	1.66	4.7	4.26	Medium vine, soft fruit
NKX 713	179.0	1.85	4.8	4.20	Medium vine, large calyx scar, too soft
Patriot	165.2	1.25	4.2	4.14	Medium vine, GS, some rough fruit
Red Bay	196.4	0.93	4.6	4.22	Large, open vine
Red Centre	229.8	1.37	4.5	4.20	Large vine, late maturing, large fruit, GS
Redback	232.2	1.56	4.7	4.16	Large vine, GS, some rough fruit
Regency	169.9	1.73	4.7	4.24	Medium vine, good fruit colour and flavour
RS902876	131.6	1.91	4.2	4.21	Not recorded
Sundance	167.0	1.12	4.6	4.12	Large vine and fruit. Some rough, GS.
Tornado	152.6	1.66	4.4	4.20	Large open vine. Large fruit, GS.
Triumph	146.2	0.83	4.7	4.06	Medium-compact vine. Firm fruit, some GS.
Zola	219.0	1.61	4.5	4.19	Tall vine, late maturing. Hard to pick.