Tomato Fruit Quality :
pre and post harvest factors

HDC PC5/C/88/0021

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Tomato Fruit Quality, Pre and Post Harvest Factors

Experiment Leaders: Dr R Holder, Efford Experimental Horticulture Station, Lymington, Hants SO4 0LZ. Tel: 0590 73341.

Miss F Richardson, Stockbridge House Experimental Horticulture Station, Cawood Selby, North Yorks, YO8 0TZ. Tel: 0757 86275/6.

Mrs H Airdrie, Luddington Experimental Horticulture Station, Stratford-on-Avon. Warwickshire, CV37 9SJ. Tel: 0789 750601.

Dr G Hobson, Institute of Horticultural Research, Worthing Road Littlehampton, West Sussex, BN17 6LP. Tel: 0903 716123.

Project Leaders: Mr G Hayman, GMAU, Martlett House, St John's Street, Chichester PO19 1UY. Tel: 0243 783291 or 787517 (until March 1988).

Mr R E Butters, ADAS, Institute of Horticultural Research, Worthing Road, Littlehampton, West Sussex, BN17 6LP. Tel: 0903 717451 (from April 1988).

Status of work: continuing

Year of experiment: 1

Report Number: 1

Period covered: 1987 season

Abstract

Work carried out at four sites in 1987 investigated many aspects of tomato fruit quality under the headings of product life, chemical composition and physical characteristics. The effect of a wide range of factors upon the final product was studied. The main results were:

a) Varieties

Trials at three sites (South, Midlands and North) identified the quality characteristics of a range of newer and standard varieties. At one site (Stockbridge House) the varieties were compared when grown in soil or rockwool. Soil-grown fruit was generally of better quality than that grown in rockwool, although the latter was firmer. At Luddington, two Mediterranean varieties gave excellent skin finish, but were unacceptable from a shape point of view. On two sites, sugar levels were low in Counter and high in 663 and 662.

b) Temperatures

The ADAS Blueprint regime gave better fruit quality than the Dutch regime.

c) Humidity and nutrition

In the winter, high humidity gave softer fruit with a reduced shelf life, but there were no clear effects from humidity differences in summer.

High conductivities reduced boxiness and uneven ripening in both winter and summer. Fine net cracking was reduced in winter and goldspot in summer by high EC. Radial cracking was increased in late summer by high EC. Low Ca levels (150 mg/l) reduced incidence of goldspot.

d) Summer CO_2 and ventilation

Summer CO_2 and various ventilation temperatures had no effect on firmness or chemical composition.

e) Reducing sugar measurement

Different methods of sap extraction and analysis were compared and recommendations made for the use of the hand-held refractometer.

f) Effect of the grading operation on quality

A 42 per cent reduction in product life was demonstrated from fruit undergoing commercial grading or passing over a simulated routine.

The full report gives detailed figures for 14 parameters in 83 tables and 10 graphs.

Objective

To investigate the effect of a range of pre and post harvest factors on the final quality of tomato fruits. To develop clear guidelines on techniques for improving fruit quality and maintaining this to the point of sale. To examine all quality aspects of possible new tomato varieties with excellent composition and flavour, which might be visually distinct and represent a premium product.

Introduction

Quality assessments from both ADAS and IHR tomato programmes have previously given greatest emphasis to visual aspects of quality. Much greater attention must now be given to quality factors such as compositional quality, firmness and post harvest life. A wide range of cultural factors, together with post harvest management procedures, are likely to affect quality expressed by these parameters.

The effects of handling and storage methods on quality is also of some concern. There has been evidence of an interaction between compositional quality of fruit and susceptibility to injury or rapid deterioration. Further evaluation of this situation is therefore important.

Development of the cherry tomato crop has demonstrated the market potential for a high quality product at premium prices. Fruit must be visually distinct and of excellent composition. A similar market is likely to exist for other tomato types, including fruit of larger size.

Materials and methods

Fruit from ADAS and IHR sites were assessed for the following quality parameters:

i) Product life (colour, weight changes, firmness)

ii) Composition (soluble solids, acidity, dry matter and sugar analysis)

iii) Physical characteristics

- ribbing
- boxiness
- nippling
- fine net cracks
- radial cracks
- evenness of colour
- goldspot
- flecking
- fruit length
- splitting
- ghost spotting

Unless otherwise stated, standardised techniques were adopted at all sites for these assessments. (Full details may be found in Appendix I).

FRUIT ASSESSED

Fruit from the following ADAS trials were assessed:

1. Efford EHS

1. P-block, Heated Variety Trial
2. F-block, Temperature regimes
3. M-block, Humidity & Nutrition Trial

2. Stockbridge House EHS

1. Heated variety trial. Rockwool and soil grown.
2. MFU, Summer CO_2 and ventilation regimes.

3. Luddington EHS

1. Unheated Variety trial.

The following trials were undertaken at IHR - Littlehampton:

1. Effects of grading and handling on tomato fruit quality.

2. Techniques for the preparation of cherry tomato sap samples and their subsequent analysis for reducing sugars.

Acknowledgements

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1. Efford EHS

1.1 P-BLOCK VARIETY TRIAL 1986/87

Treatments

Variety	Seed house	Resistance
Calypso	ZwR	TM C5 F2 V Wi
Counter (Control)	Pi/vdB	TM C5 F2 V Wi
Criterium	Pi/vdB	TM C5 F2 V Wi
Marcella	ZwR	TM C5 F2 V Wi
Mercator	Pi/vdB	TM C5 F2 V Wi
Turbo	ZwR	TM C5 F2 V Wi
662	ZwR	TM C5 F2 V Wi N
663	ZwR	
W690	Pi/vdB	TM C5 F2 V Wi
W704	Pi/vdB	TM C5 F2 V Wi N
2015	Brui	TM C5 F2 V Wi 2

Ob - an observation variety whose figures are not discussed although they appear in the detailed tables.

Culture

Sown: 1 November

First anthesis 31 December

Assessments taken: Product life + composition - weeks 14, 17, 22, 26, 30 & 34
Physical appearance - weeks 15, 19 24, 28 & 35.

Results

An overall summary of the performance of different varieties is listed in Tables 1.1 to 1.3. Only those aspects of quality of most interest have been highlighted. Full data analysis is tabulated in Appendix II. Individual variety performances were as follows:

Calypso

Following analysis of the 1987 results on fruit quality, Calypso was in general one of the best varieties of those included in the trial. Fruit firmness was similar to Counter but poorer than other varieties on several occasions. It

did not show signs of a particularly poor shelf life, except in week 22. The percentage of fruit edible after 12 days was average for the trial over the whole season (see Appendix I 1.4.4).

Chemical composition (sugar and acidity levels) were good and generally better than Counter.

The degree of boxiness was minimal throughout the season, and scores on average were the best in the trial. Fine net cracking was average, but on some occasions slightly higher than Counter. Radial cracking was low.

The incidence of uneven ripening varied over the season, although bad on occasions scores were significantly lower than other varieties in week 35 and on average Calypso had one of the lowest levels for all varieties. Levels of goldspot were fairly low.

Counter

The quality of Counter was disappointing in several respects (Table 1.1). Fruit were lacking firmness on occasions although % eatable after 12 days was slightly above average. Levels of soluble solids were low although acidity was average for the trial. Fruit showed slightly lower than average amounts of fine net cracking and although levels of radial cracking appear moderately high when averaged for the whole season, most of this developed from week 35 onwards.

The degree of uneven ripening was initially low although it became progressively worse, Counter being one of the worst affected varieties by the end of the season.

Criterium

The performance of Criterium was again average amongst other varieties in trial. Fruit were one of the firmest with slightly lower than average % uneatable after 12 days. Acidity levels were poor. In appearance fruit from Criterium

were particularly ribbed, significantly more so than other varieties and also suffered fairly high levels of fine net cracking.

Marcella

Fruit showed good shelf life and were particularly firm after 12 days. Levels of fine net cracking and radial cracking were also low.

Marcella was on a par with Counter for boxiness, and worse than Counter for uneven ripening. Furthermore, Marcella showed significantly more nippling than any of the other varieties on occasions, although fruit were otherwise of good shape with little ribbing.

Mercator

Despite being amongst the varieties with least fine net cracking, Mercator performed poorly in firmness and shelf life tests. The firmness was good after 6 days, but after 13 days, the fruits were the softest of all the varieties.

After 12 days, Mercator had produced the highest % of uneatable fruits especially from week 26 onwards. Levels of radial and fine net cracking were also higher during this period despite having been particularly low earlier in the season. This was no doubt contributory to the poor shelf life. The incidence of goldspot was lowest of all varieties.

Turbo

Despite poor firmness, especially after 6 days, the chemical composition and the physical appearance were very good. Fruit were generally well shaped (levels of boxiness significantly lower than other varieties on occasions) well coloured with low levels of radial and fine net cracking and low levels of goldspot. In terms of fruit quality Turbo was amongst the better varieties in 198

662

Product life of this variety was fairly poor. Fruit were some of the softest in the trial and suffered high percentage weight loss in comparison to other varieties. In contrast the soluble solid content of fruit was high.

Assessments of physical characteristics indicate the variety to be particularly prone to radial and fine net cracking. This probably contributes to the poor shelf life. Fruit shape was good with significantly low levels of boxiness, ribbing or uneven ripening.

663

The variety 663 did not have a particularly high incidence of any disorder, mostly showing average or below average scores in the trial. Netting, radial cracking and uneven ripening were, however, higher than average. Shelf life and fruit composition were fairly good.

W690

Firmness after 6 days was similar to Counter, although after 13 days it ranked better than Counter but slightly softer than average. Fruit were of good composition and produced better than average scores for radial cracking and goldspot. Nippling and flecking scores, however, were significantly high for W690.

W704

The variety W704 was clearly the firmest of all the varieties tested, both after 6 and 13 days. In contrast W704 had the highest incidence of boxiness all through the season, and netting and radial cracking levels were above average. Physical characteristics of W704 were disappointing given the firmness of this variety.

2015

2015 was also a firm variety with good shelf life, average composition and low incidence of boxiness and netting. Levels of radial cracking were particularly low. In contrast to other varieties such as Counter, levels of radial cracking remained low on 2015 even into late August when the problem was worst on other varieties. Fruit from 2015 were fairly long in shape and the incidence of goldspot high.

Table 1.1 Heated Variety Trial, P-Block - Overall summary 1987

Variety	Attributes				Disorders				
	Firm	Good shelf life	High % soluble solids	High acidity	Box-iness	nett-ing	Radial crack-ing	Uneven ripen-ing -	Gold spots
A: Calypso	P		*	**	**		*	*	*
B: Counter	P		P		P	*		P	P
C: Criterium	*			P		P		*	
D: Marcella	*	*		P	P	**	*	P	
F: Mercator	P	P	P			**	P		**
H: Turbo	P			*		**	*	*	*
J: 662		P	**	*	*	P	P	**	
K: 663		*	*	*		P	P	P	
L: W690	P		*	*			*		*
N: W704	**				P	P	P		
P: 2015	*	*			*	*	**		P

** : best or low incidence of disorder

* : good

P : poor or high incidence of disorder

Table 1.2 Product life and composition of tomato varieties, mean of assessments during season

Variety	Firmness % compression 6 days	% compression 12 days	% uneatable 12 days	% soluble solids	titratable acidity mEq/100 ml sap
A: Calypso	7.80	10.48	63	5.00	7.7
B: Counter	7.77	10.53	54	4.72	6.3
C: Criterium	7.17	10.03	62	4.77	5.9
D: Marcella	7.47	9.90	48	4.82	6.1
F: Mercator	7.27	10.70	81	4.63	6.5
H: Turbo	7.98	10.32	56	4.92	7.0
J: 662	7.72	10.43	74	5.08	7.5
K: 663	7 62	10.10	49	5.00	7.3
L: W690	7.77	10.28	64	4.95	7.4
N: W704	6.87	9.38	65	4.82	6.7
Ob	7.08	10.02	52	4.75	5.5
P: 2015	7.55	9.67	46	4.90	6.4
Mean	7.50	10.15	57	4.86	6.7

For full details of assessments during the season and methods of assessment see Appendices I and II.

Table 1.3 Physical characteristics of tomato varieties on a 0-4 score
Mean of 5 assessments taken during the season (wk 15-35)

Variety	Ribbing	Boxiness	Nippling	Fine net cracking	Radial cracking	Uneven ripening	Fruit shape (roundness)*
A: Calypso	.37	.03	.34	1.15	.45	.50	1.99
B: Counter (Control)	.44	.24	.35	1.02	.69	.69	2.05
C: Criterium	.69	.13	.36	1.44	.68	.52	2.11
D: Marcella	.32	.22	.68	.75	.45	.78	2.10
F Mercator	.47	.10	.45	.78	.76	.55	1.98
H: Turbo	.39	.11	.49	.75	.44	.49	1.93
J: 662	.23	.84	.49	1.96	1.15	.44	1.99
K: 663	.35	.13	.46	1.41	.79	.62	1.96
L: W690	.35	.12	.55	1.29	.56	.60	2.01
N: W704	.38	.35	.30	1.4	.85	.56	1.96
Ob	.49	.18	.40	1.17	.89	.63	2.08
P: 2015	.33	.07	.08	1.08	.39	.57	2.16
Mean	.48	.14	.41	1.18	.68	.58	1.18

*Fruit shape where 2 = round, 0 = flat, 4 = long

For fully analysed details of assessments, methods of analysis and details of scoring systems used see Appendices I and II.

Efford EHS

1.2 F-BLOCK: TEMPERATURE REGIMES

Treatments (Temperatures °C)

Propagation treatments:

	Night °C	Day °C	Vent °C
1.	15	20	21
2.	20	20	21
3.	24	24	25

then from 11 November to standing out

1.	15	20	21
2 and 3.	18	20	26

Growing house treatments:

From standing out on 19 November:

1. Blueprint

	Night °C	Day °C	Vent °C
19 November to 1st anthesis (Stage 2)	16	18	24
1st anthesis to start of pick 2 February (Stage 3)	16	20	26
Weekly reduction	16	19.5	25
	16	19.0	24
	16	18.5	23
From 23 February to end of crop	16	18	21

2. Dutch regime

	Night °C	Day C	Vent °C
19 November	19	19	20
25 November	18	18	19
8 December to 4/5 truss in flower (13 January)	17.5	18	19
13 January to end of crop	17	17.5	18

3. Combination regime

	Night	Day am		Day pm	
		Temp	Vent	Temp	Vent
19 November to 1st anthesis	16.5	17.5	18.5	18	24
1st anthesis to first pick (2 February)	17	18	10	20	26
Weekly reduction pm only	17	18	19	19.5	25
	17	18	19	19.0	24
	17	18	19	18.5	23
From 23 February to end of crop	17	18	19	18.0	21

4. BLUEPRINT AND LOW VENT (B.P.L.V.)

As for treatment 1 but with 21°C ventilation at all times.

Culture:

Sown: 17 October

Variety: Counter

First anthesis: 5-8 December.

Assessments taken: Product life and composition - weeks 12, 18, 20 24, 29, 37

Physical appearance - weeks 13, 16, 21, 25, 29, 33, 37

Results

Detailed assessments of fruit quality began in late March. By this date harvesting had been in progress for 6-7 weeks. The most serious downgrading of fruit from the Dutch regime occurred during this early period, mostly due to a high incidence of boxiness (see HDC Project report PC2/87).

Fruit quality

The different temperature regimes did have a significant effect on physical appearance. Most affected was radial cracking, and fine net cracking of the skin. Overall the assessment dates least affected was boxiness, although boxiness had been a serious problem with the Dutch regime early in the season. Product life was also affected by the temperature regimes. A summary of assessments can be found in tables 1.4 and 1.5. Full details with statistical analysis are to be found in Appendix II.

Blueprint regime:

In spring 1987 the Blueprint regime produced tomatoes with the lowest incidence of radial and fine net cracking, goldspot and ribbing. Levels were significantly lower than the Dutch regime in week 21 (mid May), (week 16 for ribbing).

The quality of fruit from the Blueprint regime was consistently better than that from the Dutch regime in most characteristics, excepting slightly increased levels of uneven ripening found in wk 21 to 25 (mid May to mid June). Over the whole season fruit appeared to have one of the best shelf life results of all treatments with the least fruit uneatable after 12 days. Chemical composition and firmness were average.

Dutch regime:

The fruit quality from the Dutch regime was particularly poor in spring 1987. Apart from the significant, lower percentage Class I in February and March, (due to poor shape (see Report PC2/87, p12)), the fruits were badly affected by fine net and radial cracking, goldspot and ribbing reaching their highest levels around week 21 (mid May).

Shelf life was similarly affected and fruit was softer than other treatments in this period (week 20). The high incidence of fine net and radial cracking is likely to be responsible for the Dutch regime's poorer shelf life. In weeks 18-20 (end April to beginning of May) weight loss during shelf life was also particularly high.

The quality of tomatoes from the Dutch treatment improved from May onwards and was on a par with Blueprint tomatoes thereafter.

Combination regime:

Fruit quality from the combination regime was significantly better than the Dutch regime (i.e. for ribbing, radial and fine net cracking and goldspot), although levels of these characteristics (with the exception of goldspot) were slightly higher than in the Blueprint regime. The severe peak in May of fine net cracking, radial cracking and goldspot was not, however, experienced as it was with the Dutch regime.

Blueprint and low vent regime:

This regime showed the advantage in quality produced by the Blueprint regime, but to a lesser extent. It did not improve fruit quality over that of the Blueprint neither did the low vent cause any fruit quality problems.

Conclusion

Temperature has had important effects on the fruit quality. The Blueprint regime with relatively high day and low night temperatures has given a better fruit quality than the Dutch regime, with lower day and higher night temperatures. The difference was especially marked in May.

The outside weather conditions in 1987, particularly the low light in June, could have been unfortunate for the Dutch treatment. Therefore the experiment is being carried out again in 1988 with the Dutch and the Blueprint regime and with three varieties.

Table 1.4 Chemical composition and product life of tomato fruit. F-Block Temperature regimes

Mean of assessments throughout season

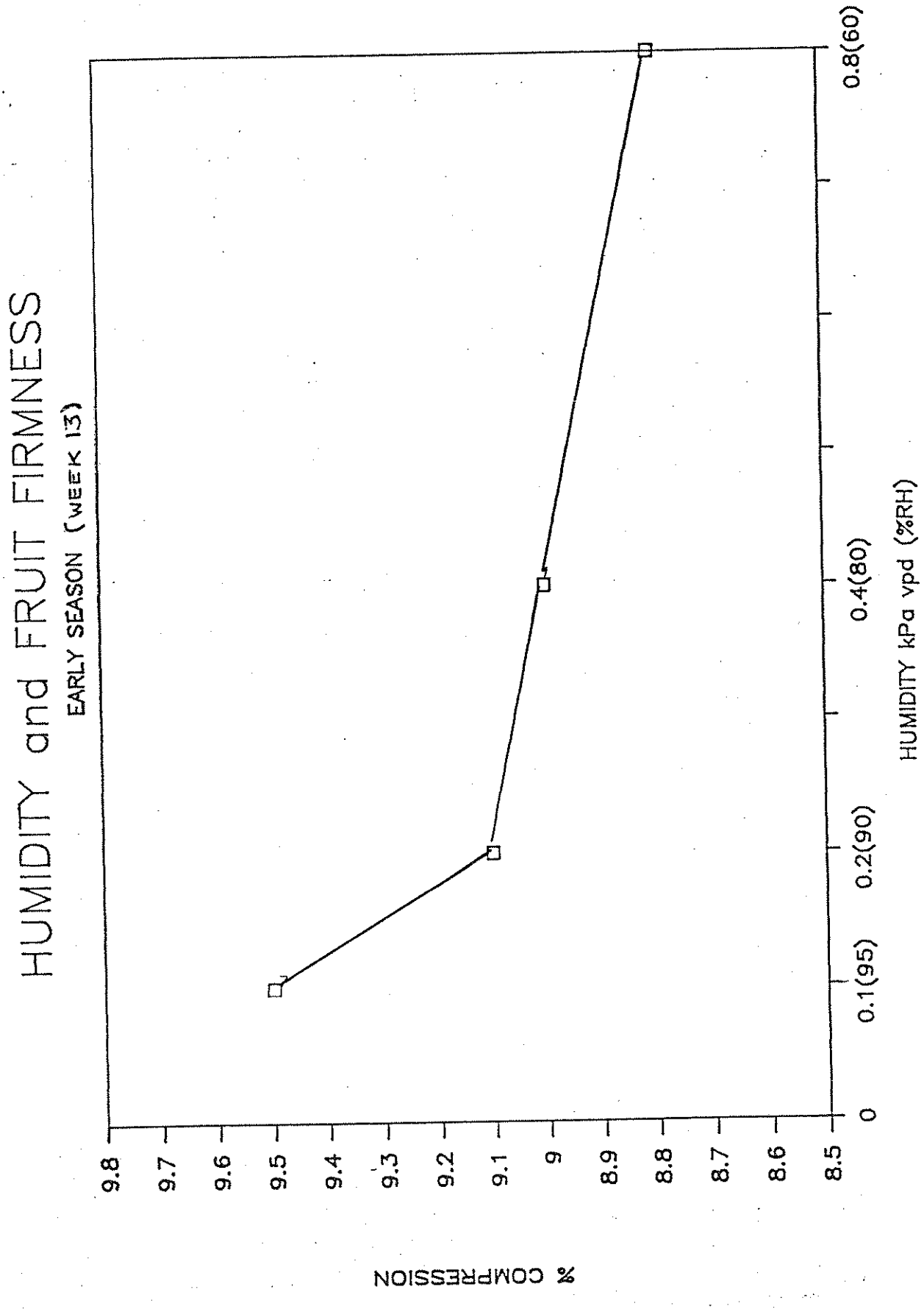
Treatments	Firmness % compression 6 days	% uneatable 12 days	% of original wt after 6 days	% soluble solids	titratable acidity (mEq/100 ml sap)
Blue print	7.68	19	96.3	4.98	8.40
Dutch	7.70	36	95.9	5.15	8.57
Combination	7.55	32	96.4	4.88	8.18
Blue print + low vent.	7.43	28	96.4	5.02	7.93
Week 20 only					
Blue print	7.7	40	96.3	5.2	8.4
Dutch	8.6	70	94.7	5.8	8.4
Combination	7.8	45	96.0	5.1	8.4
Blue print + low vent.	7.9	40	96.3	5.0	7.8

Table 1.5 Physical characteristics of tomato fruit. F-Block Temperature regimes

Mean of 6 assessments throughout season

Treatments	Ribbing	Boxiness	Fine net cracking	Radial cracking	Uneven ripening	Goldspot
Blue print	0.22	0.17	0.26	0.60	0.68	0.97
Dutch	0.52	0.29	0.75	1.04	0.52	0.95
Combination	0.36	0.17	0.54	0.88	0.49	0.73
Blue print + low vent.	0.31	0.33	0.44	0.72	0.50	1.03
Week 21						
Blue print	0.39	0.14	0.22	0.25	0.62	0.34
Dutch	1.29	0.28	1.75	1.25	0.39	1.55
Combination	0.79	0.09	0.42	0.34	0.08	0.64
Blue print + low vent.	0.59	0.29	0.40	0.49	0.25	0.90

Fig 1.3.1


HUMIDITY and FRUIT FIRMNESS
EARLY SEASON (WEEK 13)
% COMPRESSION
9.8
9.7
9.6
9.5
9.4
9.3
9.2
9.1
9
8.9
8.8
8.7
8.6
8.5
0
0.1(95)
0.2(90)
0.4(80)
0.8(60)
HUMIDITY kPa vpd (%RH)

Efford EHS

1.3 M-BLOCK HUMIDITY & NUTRITION TRIAL

Sown 24 October

Variety: Counter (Pi)

I WINTER TREATMENTS

Humidity: From 15 January to 12 February 1987:

a 0.1 kPa vpd, (95% rh at 18°C)

b. 0.2 kPa vpd, (90% rh at 18°C)

c. 0.4 kPa vpd, (80% rh at 18°C)

d. 0.8 kPa vpd, (60% rh at 18°C).

Nutrition: From January to March:

Two conductivities (5.0 and 7.0 mS)

Two calcium concentrations (150 and 300 mg Ca litre^{-1})

which gave slab concentrations (200 and 400 mg Ca litre^{-1})

respectively).

Assessments taken: Product life & composition - weeks 13 + 15

Physical appearance - weeks 12, 14, 18, (25), 26.

Results

Tomato fruit quality: A summary of results is found in Tables 1.6 and 1.7.

Full details with statistical analysis are presented in Appendix II.

HUMIDITY

The main humidity treatment did not have any significant effect on the incidence of disorders, but an effect could be seen on the product life. Tomatoes from the highest humidity (0.1 kPa vpd) lost most weight during the shelf life period,and the fruits were softer when measured as % compression of fruit on

the firmness meter (fig 1.3.1). The fruits also lost shelf life faster than other treatments, after 12 days 97% of the fruits from the highest humidity were uneatable compared to 78% for the lowest humidity level.

However, despite the poorer product life the tomatoes from the highest humidity level appeared to contain slightly more sugar (soluble solids) and acid, in week 13, although this was not confirmed in week 15.

EFFECTS OF NUTRITION

In contrast to the main humidity treatments the biggest effect of nutritional sub-treatments was manifest in the incidence of various disorders.

Boxiness: High EC appears to reduce the extent of boxiness, particularly in association with a low calcium concentration.

Fine net cracking: High EC significantly reduced the incidence of fine net cracking early in the season (week 14).

Goldspot: The levels of goldspot were significantly higher under high calcium concentrations in contrast to low calcium treatments.

Radial cracking: Very low levels of radial cracking were apparent during the early season.

Uneven ripening, ribbing, nippling and flecking were also recorded but no real differences between treatments were apparent.

Composition: High EC sub-treatments produced fruit with higher % soluble solids and with slightly higher levels of acidity.

Conclusion

High air humidity (0.1 kPa = 95% rh at 18°C) during early spring did not cause problems in physical appearance, but fruit firmness and shelf life were reduced.

Nutrition treatments affected physical characteristics. Boxiness, uneven ripening and netting were reduced at higher EC levels (EC 7.0 mS), whilst low calcium (150 mg Ca litre-1) reduced the incidence of goldspot.

Table 1.6 Composition and product life of tomato fruit. M-Block Humidity and Nutrition Trial (Winter treatments - Assessed week 13)

Treatments	Firmness % compression at 6 days	% uneatable after 12 days	% of original wt after 6 days	% soluble solids	titratable acidity (mEq/100 ml sap)
Humidity regime					
kPa vpd					
a. 0.1	9.48	97.0	93.3	4.58	7.7
b. 0.2	9.05	83.5	94.2	4.50	6.3
c. 0.4	9.03	90.0	94.5	4.33	4.5
d. 0.8	8.83	77.5	95.0	4.28	4.5
Nutritional regime (conductivity /mg Ca l^{-1})					
5/150	8.83	86.3	94.0	4.30	4.8
5/300	9.53	88.5	94.3	4.33	5.6
7/150	8.80	88.5	94.5	4.55	5.3
7/300	9.23	84.8	94.1	4.50	6.5

Table 1.7 Physical characteristics of tomato fruit. M-Block Humidity & Nutrition Trial (Winter treatments) Assessed week 14

Treatments	Boxiness	Fine net cracking	Radial cracking (assessed week 18)	Goldspot
Humidity regime				
kPa vpd				
a. 0.1	0.44	0.76	0.55	2.13
b. 0.2	0.34	0.84	0.25	1.41
c. 0.4	0.31	0.74	0.29	1.20
d. 0.8	0.43	1.48	0.13	1.43
Nutritional regime (conductivity / mg Ca l^{-1})				
5/150	0.36	1.06	0.44	0.94
5/300	0.69	1.10	0.28	1.78
7/150	0.16	0.88	0.26	1.19
7/300	0.30	0.78	0.24	2.26

II. SUMMER TREATMENTS

Following the winter treatments applied until 12 February a further set of humidity and nutritional treatments were applied from mid June to mid September.

Humidity

Treatments maintained from mid June as long as outside weather conditions allowed.

	Day	/	Night
1.	High		High
2.	High		Low
3.	Low		High
4.	Low		Low

Treatment levels (kPa vpd) *

	Day Min.	Day Max.	Night Min.	Night Max.	
Low	2.0	0.8	2.0	0.8	with minimum pipe heat and min. vent
High	0.8	0.2	0.2	0.1	no min. pipe or min. vent

The high treatment received automatic fogging as required to raise the humidity.

* At 20°C

kPa		RH
0.1	=	96%
0.2	=	91%
0.8	=	66%
2.0	=	40%

Nutrition:

Four conductivity levels maintained from mid June to mid September

EC: 2.5, 3.5, 4.5 and 5.5 in slab solution (not in applied solution)

Fruits were affected in mid August and September (app. week 32-40)

Assessments taken: Product life & composition - weeks 28, 32, 36, 40

Physical appearance - weeks 26, 30, 34, 40

Results

Tomato fruit quality: A summary of results can be found in Tables 1.8 and 1.9. Full tables with statistical analysis may be found in Appendix II.

EFFECTS OF HUMIDITY

Incidence of disorders

The effect of diurnal changes between high and low humidity levels did not have any significant effect on the incidence of major disorders when compared to continuous humidity treatments.

Product life

The humidity treatments did not change the product life to any great extent but there is evidence of a trend that high humidity at nights gave shorter shelf life. Fruits lost slightly more weight from the LH (low day, high night) and the HH (high day, high night) regimes during storage, and more fruits were classified as uneatable after 12 days from these treatments.

Composition:

No difference in % soluble solids and acidity could be found.

Effects of Nutrition

Incidence of disorders:

Boxiness was reduced by higher EC levels (4.5 and 5.5 mS) as was uneven ripening and goldspot. In contrast, late in the season (week 40) radial cracking was worse from high EC treatments (5.5 mS) (fig 1.3.2). Other disorders did not appear to be significantly affected by EC levels, although observations on blossom end rot indicated levels increased sharply at higher conductivities.

Product life:

The EC levels had no clear effect on the keeping quality.

Composition:

The % soluble solids and the acidity both increased with the increasing conductivity levels.

Conclusion (Summer)

The continuous high or low humidity (0.1 or 0.8 kPa vpd respectively) and the diurnal changes in humidity did not have any major effects on the physical appearance of the tomatoes. High night humidity appears to have had a slightly

unfavourable effect on shelf life, but with no noticeable effect on composition.

Under the higher conductivity levels less boxiness, uneven ripening and goldspot were seen. Radial cracking was increased with high conductivity levels.

Table 1.8 Physical characteristics of tomato fruit. M-Block Humidity & Nutrition Trial (Summer treatments) Assessed week 34 or 40

Treatments	Boxiness (week 34)	Fine net cracking (week 34)	Radial cracking (week 40)	Uneven ripening (week 40)	Goldspot (week 40)
Humidity regimes					
LL	0.14	0.49	2.44	0.98	0.88
LH	0.18	0.69	2.45	0.85	0.64
HL	0.05	0.75	2.19	1.08	0.90
HH	0.19	0.91	2.58	0.78	0.99
Conductivity					
2.5	0.26	0.81	1.83	1.49	1.51
3.5	0.10	0.74	2.38	1.06	1.08
4.5	0.15	0.53	2.64	0.71	0.60
5.5	0.04	0.76	2.81	0.41	0.21

Table 1.9 Composition and product life of tomato fruit. M-Block Humidity + Nutrition Trial (Summer treatments assessed week 40)

Treatments	Firmness % compression after 6 days week 36	% uneatable after 12 days	% of original fruit wt (6 days)	% soluble solids	titratable acidity (mEq/100 ml sap)
Humidity regimes					
LL	7.25	49.5	96.0	5.05	6.3
LH	7.43	70.5	95.8	4.95	6.0
HL	7.40	48.5	96.1	5.13	6.2
HH	7.48	57.5	95.6	4.95	6.2
Conductivity					
2.5	7.35	51.8	96.0	4.65	5.1
3.5	7.35	54.2	96.0	4.93	6.0
4.5	7.33	66.0	95.8	5.08	6.5
5.5	7.53	53.9	95.7	5.43	7.6

2. Stockbridge House EHS

2.1 Heated Tomato Variety trial Rockwool + Soil comparison

Treatments

Varieties	Media
662	a) soil
Counter	b) rockwool
W704	
Turbo	
Mercator	
Marathon	
W690	
Goldstar	
Calypso	
Marcella	
663	
Criterium	

Sown:	30 December
Planted:	10 February (rockwool)
	17 February (soil)
Assessments taken:	(May), June, July, August

Results

Following statistical analysis of product life and assessments of fruit characteristics significant differences were found both between media and also between varieties. Summarised tables of results are listed in Tables 2.1 to 2.6.

Product life

When the pattern of distribution of firmness readings were analysed samples were shown to be skewed with a greater degree of 'scatter' at the soft end of the scale. This suggests that there were very few soft fruit in each batch. For this reason results were logarithmically transformed to give a more accurate measurement of variance.

Table 2.1 Fruit firmness (mm depression) averaged over season

Variety	Media Soil	Rockwool	Mean
662	2.01 (0.29)	1.86 (0.26)	1.93 (0.28)
663	1.96 (0.28)	1.94 (0.27)	1.95 (0.27)
W690	2.17 (0.32)	1.99 (0.28)	2.08 (0.30)
W704	1.94 (0.28)	1.89 (0.26)	1.91 (0.27)
Calypso	2.07 (0.31)	1.97 (0.28)	2.02 (0.29)
Counter	2.07 (0.30)	1.90 (0.26)	1.99 (0.28)
Criterium	1.88 (0.26)	1.76 (0.22)	1.82 (0.24)
Goldstar	1.97 (0.28)	1.89 (0.26)	1.93 (0.27)
Marathon	2.22 (0.34)	2.12 (0.31)	2.17 (0.32)
Marcella	2.27 (0.34)	2.00 (0.29)	2.13 (0.31)
Mercator	1.96 (0.28)	1.91 (0.27)	1.94 (0.28)
Turbo	2.17 (0.32)	1.84 (0.25)	2.00 (0.29)
Mean	2.06 (0.30)	1.92 (0.27)	

SED (between var. means) = 0.011 ***

LSD (between variety means) = 0.022
p = 0.05

SED (between media means) = 0.004 ***

LSD
p = 0.05 (between media means) = 0.009

(Statistical analysis refers to logarithmically transformed data - in brackets).

Table 2.2 Tomato Quality 1987 - % dry weights Stockbridge House EHS

Soil

Variety	May RW	May Soil	June RW	June Soil	July RW	July Soil	August RW	August Soil
662	4.8	5.1	5.1	5.3	5.8	5.9	5.4	5.9
Counter	4.6	4.9	5.1	5.2	5.0	5.8	5.1	5.4
W704	4.7	4.9	4.8	5.0	5.4	5.6	4.7	5.5
Turbo	4.4	4.8	5.3	5.3	5.5	6.2	5.4	5.9
Mercator	4.7	5.0	4.9	4.8	5.4	5.7	5.1	5.5
Marathon	4.7	4.9	4.9	5.3	5.2	6.1	5.3	5.5
W690	4.4	4.9	5.1	5.6	5.3	5.7	5.4	5.9
Goldstar	4.5	4.9	5.1	4.9	5.7	6.1	5.5	5.7
Calypso	4.6	4.8	5.4	5.3	6.0	6.0	5.5	5.9
Marcella	4.4	4.9	4.9	5.2	5.5	6.3	5.1	5.8
663	4.5	4.9	5.3	5.3	5.6	6.1	5.5	5.8
Criterium	4.4	4.6	5.2	5.0	5.1	5.8	5.0	5.2
Mean	4.5	4.9	5.1	5.2	5.5	5.9	5.3	5.7

Table 2.3 Reducing sugar analysis of tomato fruit (g/100 ml)

Rockwool

Variety	June RW	Soil	July RW	Soil	Aug (17) RW	Soil	Mean
662	3.378	2.575	3.326	3.068	3.242	3.320	3.152
Counter	2.677	2.453	2.696	2.714	2.854	2.789	2.697
W704	2.914	2.662	3.035	2.999	2.798	3.297	2.951
Turbo	2.821	2.695	2.933	3.275	3.670	3.320	3.119
Mercator	2.655	2.422E	2.772	2.964	3.011	2.911	2.789
Marathon	2.631	2.418	2.872	3.142	2.891	2.952	2.818
W690	2.824	2.848	3.198	3.193	3.216	3.292	3.095
Goldstar	2.742	2.593	3.374	3.004	3.198	3.109	3.003
Calypso	2.917	2.643	2.618	3.178	3.149	3.228	2.956
Marcella	2.999	2.736E	3.238	3.203	2.256	3.439	2.979
663	3.018	2.684	3.628	3.305	3.423	3.331	3.232
Criterium	2.577	2.411	2.954	2.923	2.886	2.861	2.769
Mean	2.85	2.60	3.05	3.08	3.05	3.15	

E = estimated

Highly significant differences were evident between the media. Fruit grown in rockwool tended to be firmer than that grown on soil (Table 2.1).

Amongst the varieties, differences were also evident, Marathon and Marcella were shown to be significantly softer than other varieties and Criterium firmer.

Physical characteristics

Differences were apparent throughout the season both between different varieties and between the rockwool and soil substrates.

Ribbing: This was more extensive on rockwool grown crops and was particularly pronounced on the variety Criterium (Table 2.4).

Boxiness: Fruit from the rockwool crop mostly showed a higher incidence of boxiness in June but no difference in July and August. Amongst the varieties, Mercator was worse affected and Calypso, least affected (Table 2.5).

Fine net cracking: (Table 2.6) Worse on rockwool early in the season (June and July) but lessening in extent later in the summer. 662 was worse affected overall, whilst varieties such as Counter, Turbo, and to a lesser extent, W690 and Goldstar, appeared relatively free from the disorder.

Assessments of the other physical characteristics of the fruit did not reveal meaningful differencies between either varieties or the type of growing media.

Composition

Dry weight assessments showed that fruit from soil grown plants had a slightly higher dry matter content than those grown on rockwool (Table 2.2), with an average 5.4% dry weight versus 5.1% for the rockwool crop. This is probably

related to larger size of fruit from the rockwool crop. There were no marked differences between varieties, although dry matter content appeared higher from fruits maturing in July and August (fig 2.1.1).

The figures for reducing sugars (Table 2.3) indicate some differences between varieties. 663, 662 and Turbo have generally higher sugar levels, while Counter and Criterium were low in sugar. These differences showed consistently through June, July and August.

Conclusions

1. The media in which tomatoes are grown appears to have a marked effect on fruit quality.

2. Fruit grown on rockwool were firmer but showed higher levels of fine net cracking, were more ribbed, and possessed a lower dry matter content than fruit grown in soil. Fruit was more boxy from rockwool in June.

3. The quality of soil grown fruit was generally better than the rockwool grown fruit.

4. The varieties also showed marked differences in quality.

5. Marathon and Marcella were softer than other types and Criterium firmer.

6. 662 was badly affected by fine net cracking and Criterium by ribbing. Mercator was more prone to boxiness in comparison to other varieties.

7. Counter and Criterium appeared to have rather low sugar levels compared with 663, 662 and Turbo.

Fig 2.1.1

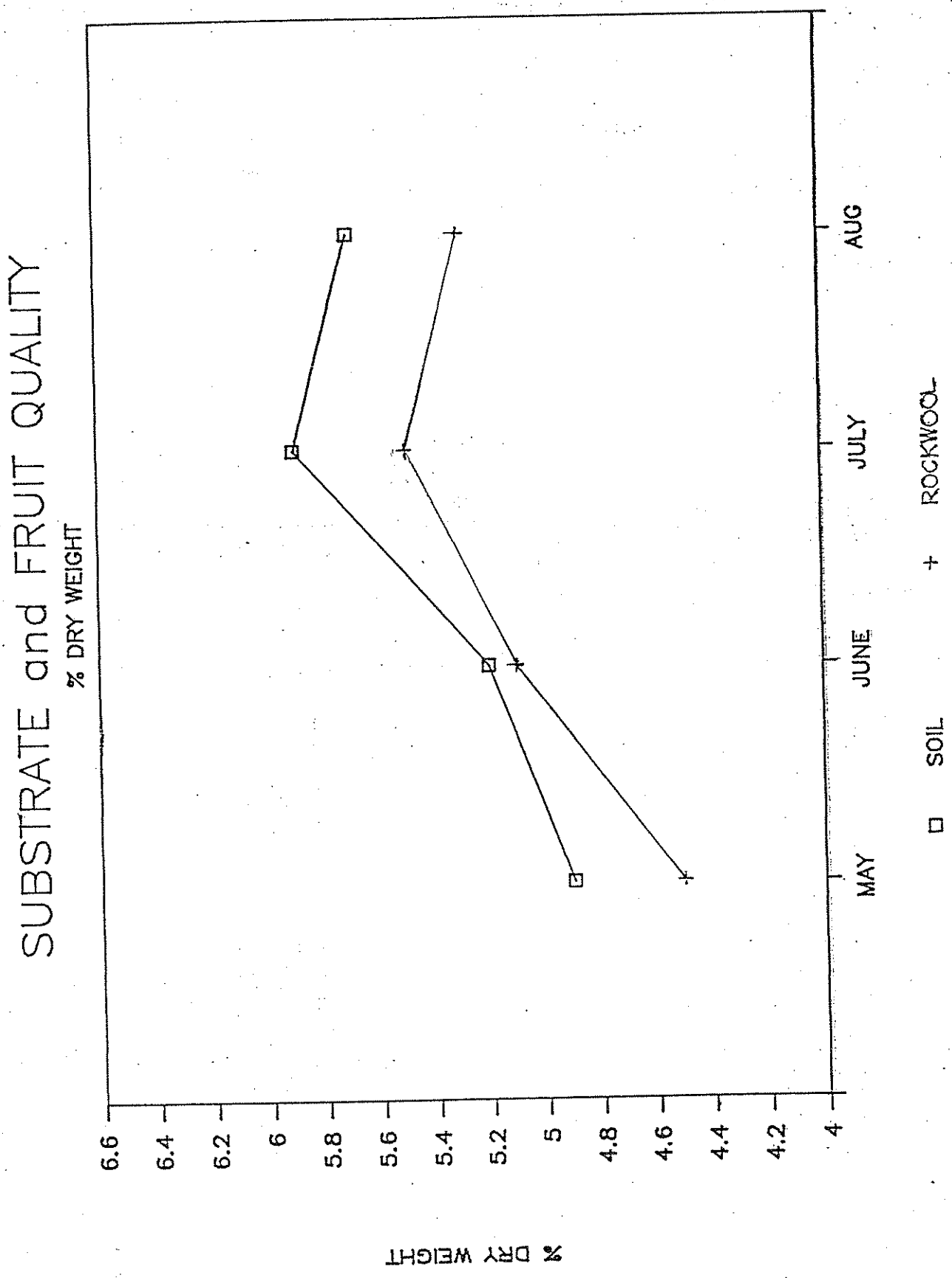

SUBSTRATE and FRUIT QUALITY
% DRY WEIGHT
6.6
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
MAY
JUNE
JULY
AUG
SOIL
ROCKWOOL
% DRY WEIGHT

Table 2.4 Tomato Quality 1987 - Ribbing (0-4) Stockbridge House EHS

Variety	June RW	Soil	July RW	Soil	August RW	Soil
662	0.15	0.15	0.05	0	0.15	0.05
Counter	0.45	0.25	0.40	0	0.60	0.05
W704	0.70	0.20	0	0	0.50	0.05
Turbo	0.30	0.50	0.10	0	0.20	0
Mercator	0.95	0.50	0.10	0.05	0.60	0.15
Marathon	1.00	0.45	0.30	0	1.00	0
W690	0.55	0.40	0.45	0	0.20	0.05
Goldstar	0.15	0.25	0	0	0.35	0
Calypso	0.30	0.30	0	0	0.35	0.15
Marcella	0.55	0.25	0.15	0	0.10	0
663	0.25	0.25	0.15	0	0.95	0.15
Criterium	0.75	1.15	0.85	0.50	2.35	0.20
Mean	0.51	0.39	0.22	0.05	0.61	0.07

Table 2 5 Tomato Quality 1987 - Boxiness (0-4) Stockbridge House EHS

Soil

Variety	June RW	Soil	July RW	Soil	August RW	Soil
662	0.50	0.10	0	0.05	0.05	0.25
Counter	0.30	0.35	0.15	0.20	0.65	0.50
W704	0.55	0.45	0.20	0	0.35	0.45
Turbo	0.30	0.25	0.15	0.05	0.35	0.60
Mercator	0.90	0.70	0.25	0	0.30	0.45
Marathon	0.70	0.60	0	0.25	0.30	0.20
W690	0.60	0.25	0	0	0.05	0.60
Goldstar	0.30	0.30	0.05	0	0.20	0.75
Calypso	0	0	0	0	0.05	0.10
Marcella	0.55	0.05	0.20	0	0.40	0.85
663	0.30	0.15	0.10	0	0.15	0.40
Criterium	0.35	0.05	0	0.05	0.20	0.10
Mean	0.45	0.27	0.09	0.05	0.28	0.44

Table 2.6 Tomato Quality 1987 - Fine net cracking (0-4) Stockbridge House EHS

Variety	June RW	Soil	July RW	Soil	August RW	Soil	Mean
662	0.65	0.05	1.05	0.70	1.55	1.75	0.96
Counter	0	0.15	0.50	0	0.05	0.70	0.23
W704	0.45	0.30	1.55	0.40	0.50	0.75	0.66
Turbo	0.05	0.10	0.90	0	0.30	0.30	0.28
Mercator	0.20	0	0.30	0.25	0.85	1.15	0.46
Marathon	0.60	0.20	0.80	0.05	1.00	1.20	0.64
W690	0.40	0.30	0.75	0.30	0.40	0.10	0.38
Goldstar	0.45	0.05	0.85	0.30	0.35	0.10	0.35
Calypso	0.45	0.20	1.60	0.30	0.75	1.20	0.75
Marcella	0.45	0.10	0.65	0.15	0.85	0.75	0.49
663	0.15	0.35	1.25	0.25	0.85	0.40	0.54
Criterium	0.40	0.20	1.05	0.05	1.05	0.50	0.54
Mean	0.35	0.17	0.94	0.23	0.71	0.74	

2.2 The effect of summer CO_2 enrichment and ventilation temperatures

Treatments

E1 Control, 1000 vpm CO_2 to end of April, then no summer CO_2, Stage IV ventilation 21°C.

E2 CO_2 at 1000 vpm to end of April, then 335 vpm, regardless of ventilator position, Stage IV ventilation 21°C.

E3 Delayed ventilation treatment, as E2 but Stage IV ventilation 26°C.

E4 Low ventilation set-point, as E1 but Stage IV ventilation 19°C.

Culture

Sown: 23 January 1987

Varieties: Counter, Criterium

Planted: 10 March

Assessments taken: June, July and August.

Results and Discussion

Assessments indicate that the CO_2 and ventilation regime did not have a major effect on fruit firmness. Criterium appeared to be a slightly firmer variety than Counter (Table 2.7).

Although different CO_2 regimes might be expected to affect the composition of the fruit no consistent trends in reducing sugar content were detected (Table 2.8).

Conclusions

Summer CO_2 treatments and altered ventilation temperatures did not affect fruit quality in terms of firmness or composition.

Table 2.7 Tomato fruit firmness (mm depression) MFU CO_2 and ventilation trial

Counter

		June	July	August	Mean
E1 Control	: No summer CO_2 Stage IV vent @ 21°C	1 59	2.02	2.08	1.90
E2 Summer CO_2	: Summer CO_2 @ 335vpm Stage IV vent @ 21°C	1.67	1.98	2.03	1.89
E3 Summer CO_2 + delayed vent	: Summer CO_2 @ 335vpm Stage IV vent @ 26°C	1.84	1.88	2.11	1.94
E4 Low vent	: No summer CO_2 Stage IV vent @ 19°C	1.63	1.86	1.98	1.82
	Mean	1.68	1.94	2.05	

Criterium

		June	July	August	Mean
E1 Control	: No summer CO_2 Stage IV vent @ 21°C	1.47	1.69	1.89	1.68
E2 Summer CO_2	: Summer CO_2 @ 335vpm Stage IV vent @ 21°C	1.62	1.82	1.60	1.68
E3 Summer CO_2 + delayed vent	: Summer CO_2 @ 336vpm Stage IV vent @ 26°C	1.53	1.78	1.61	1.64
E4 Low vent	: No summer CO_2 Stage IV vent @ 19°C	1.53	1.80	1.94	1.76
	Mean	1.54	1.77	1.76	

Table 2.8 Reducing sugar content (g/100 ml) of tomato fruit. CO_2 and ventilation trial

Counter

	July	August	Mean
E1	3.18	2.78	2.98
E2	2.45	2.58	2.51
E3	2.53	2.80	2.67
E4	2.49	2.67	2.58

Criterium

	July	August	Mean
E1	2.52	3.02	2.77
E2	2.45	2.52	2.49
E3	2.42	3.31	2.86
E4	2.41	2.85	2.63

3. Luddington EHS

3.1 Unheated tomato variety trial

Treatments:

Counter	2015
Criterium	Goldstar
Turbo	RS85042
662	Shirley
663	RS84065
W690	Dario)
W1007	Novy) sub trial
	B366)

Sown:	13 March
Planted:	24 April
Start of picking	3 July
Substrate:	Soil
Assessments taken:	Product life and composition - weeks 32, 34, 37 & 39
	Physical appearance - weeks 30, 32, 34 & 36

Results and Discussion

Differences between varieties were very marked for some physical characteristics and product life assessments but were not apparent with respect to the chemical composition of the fruit. Changes throughout the season were, however, very evident.

Physical characteristics: (Table 3.1)

Radial cracking: Levels remained fairly constant throughout the season and the problem was never extensive. Varieties which appeared to be most susceptible were RS84065 and, to a lesser extent, W1007, 662 and Counter. Dario, Novy and Shirley showed very little radial cracking most of the season.

Fine net cracking: This problem was particularly extensive in the period around week 34 (late August) and week 36 (early September). Where significant differences between varieties are evident 662, 663, W1007, Goldstar, RS85042 and RS84065 appear to be more susceptible than the varieties Dario, Novy and Shirley.

Goldspot: Levels changed little throughout the season. Varieties which consistently retained a low incidence of the disorder include Novy, B366 and Shirley. Goldstar, 663, W1007 and RS84065 generally showed more goldspot than the other varieties in trial.

Ribbing: Ribbing was generally present at only low levels for most varieties. The Mediterranean types Dario and Novy, however, were particularly affected and for this reason were less desirable despite other quality attributes. Amongst the remaining North European tomato varieties Criterium was the worst affected type. 2015 showed very low levels overall.

Nippling: Again present in very low levels and a problem only on the variety Dario.

Boxiness: Boxiness, a category in this instance which also includes slab sidedness and general poor shape, was only present in low levels on most varieties. Dario was particularly prone with B366 and Shirley also slightly affected.

Fruit length: An indicator for 'roundness'. Scores deviating from 2.0 show predisposition for 'flat' or 'long' fruit. Varieties tending towards flatter shaped fruit include B366, Novy, Turbo, whilst those tending towards 'longer' fruit include 662, W690, Dario and W1007.

Product life

Few differences between varieties were apparent. Firmness tests after 6 days shelf life from fruit harvested in early August suggest 663 to be a soft variety, whilst Novy and B366 are firmer varieties. The latter finding was consistent in later tests. Varieties with slightly less weight loss during shelf life include Novy, Shirley and Dario (see Table 3.2).

Composition

The percentage of soluble solids in fruit increased throughout the season. There were some indications that levels in Novy and B366 were slightly higher than other varieties (Table 3.2). Acidity increased during the season but there were no consistent differences between varieties.

Conclusions

1. The varieties 662, W1007, RS84065 and Goldstar were particularly prone to skin finish problems when grown as an unheated crop in 1987. 663 and RS85042 also suffered with fine net cracking.

2. The Mediterranean varieties Dario and Novy produced fruit with excellent skin finish, as did B366 (albeit to a lesser extent). The older variety Shirley was also good for skin finish, with Turbo and 2015 also producing a reasonable finish.

3. Novy and B366 also possessed good shelf life and firmness.

4. Ribbing of fruit was serious on the varieties Dario, Novy and Criterium as was boxiness and slabsidedness on Dario.

Table 3.1 Physical characteristics of tomato varieties on a 0-4 score. Mean of 4 assessments taken during the season (weeks 30-36)

Variety	Ribbing	Boxiness	Nippling	Fine net cracking	Radial cracking	Goldspot
Counter	0.25	0.03	0.14	0.46	0.87	2.67
Criterium	0.42	0.03	0.25	0.59	0.63	2.94
Turbo	0.35	0	0.09	0.49	0.32	2.70
662	0.16	0	0.30	0.99	0.74	2.46
663	0.26	0.02	0.18	0.94	0.52	3.17
W690	0.19	0	0.11	0.76	0.54	2.91
W1007	0.17	0	0.07	1.04	1.10	3.02
2015	0.04	0	0.02	0.61	0.37	2.77
Goldstar	0.15	0.01	0	1.39	0.70	3.35
RS85042	0.23	0.02	0	1.33	0.52	2.66
Shirley	0.26	0.13	0.05	0.19	0.10	1.96
RS84065	0.39	0.04	0.02	1.39	1.34	3.19
Dario	2.04	1.88	0.45	0.05	0.19	2.67
Novy	1.84	0.05	0.01	0	0.09	1.42
B366	0.57	0.13	0	0.49	0.31	1.68

Table 3·2 Product life and composition of tomato varieties. Mean of assessments during season

Variety	Mean compression (mm) 6 days	% of original weight after 6 days	% soluble solids	Titratable acidity (mEq/100 ml sap)
Counter	3.33	94.2	4.5	7.4
Criterium	3.13	92.4	4.5	7.1
Turbo	3.25	94.7	4.6	7.4
662	3.40	93.0	4.8	7.8
663	3.63	93.5	4.9	7.6
W690	3.61	94.6	4.6	7.4
W1007	3.75	93.7	4.5	7.6
2015	3.23	93.5	4.6	7.1
Goldstar	3.14	93.6	4.4	7.4
RS85042	3.27	94.0	4.6	7.8
Shirley	3.71	95.7	4.6	7.8
RS84065	3.32	91.9	4.7	7.1
Dano	3.44	95.5	4.3	7.8
Novy	2.86	96.9	5.0	8.1
B366	2.98	94.5	5.1	7.8

IHR, Littlehampton

4.1 Different methods for the preparation of cherry tomato sap samples and their subsequent analysis for reducing sugars

Introduction

One of the quickest and easiest methods for obtaining a rough idea of the compositional quality of cherry tomato fruit is to pick a nearly-ripe fruit cut it in half with a sharp knife and squeeze a few drops of the free liquid onto the stage of a hand-held refractometer calibrated for the range 0 - 10° Brix. Within a few seconds, the instrument gives a reading in ° Brix which is directly related to % sucrose and is dependent on the total soluble solids content of the sap. It is important, however, to determine how reliable these figures were, whether the accuracy of the reading would be improved if half-a-dozen fruit were used to provide a composite sample, and whether it was worthwhile to use a high-speed macerator to break up the tissue much more efficiently. The standard method for reducing sugar analysis is to freeze a sample of fruit overnight at -18°C, thaw it the next day, clarify the sample from suspended solid matter, precipitate the proteins and dilute the sample. Reducing sugars are then determined by the use of a Technicon AutoAnalyzer.

Materials and methods

The source of the fruit and the method for juice extraction applied are shown in Appendix III. The standard method ('freeze and squeeze') was always carried out, and in a proportion of cases ('macerate'), another sample of sap was prepared after thoroughly macerating the tissue using an Ultra-Turrix. Finally, 'hand squeeze' involved breaking up half-a-dozen fruit by hand as thoroughly as possible and separating a sap sample from the debris. Another typical fruit was selected, cut in half and a drop of the free juice placed on the stage of a hand-held refractometer.

Results and Discussion

The relation between the refractometer readings as % sucrose of the free juice and the sugar content in freeze-thaw sap prepared from the same batches of fruit is shown in Figure 4.1. The correlation coefficient is r=0.651 (31 df), and these results emphasise that in some circumstances this method, while quick and easy, could lead to a false impression about the true sugar content. For this reason it cannot be recommended. When a composite sample of sap was prepared, refractive index measurements gave a rather better guide to the true sugar content (Figure 4.2), with a coefficient of r=0.722 (29 df). It must be remembered that in a typical tomato fruit, a preponderance of the sugar is in the locular walls while the locular cavity contains liquid relatively high in organic acids. Therefore it is not surprising that the easily extracted liquid round the seeds does not give a particularly accurate measure of the sugar content of the whole fruit.

The relation between the refractometer readings and the specific content of reducing sugars both using the same sample of sap prepared by the freeze-thaw technique is shown in Figure 4.3. The coefficient was calculated to be r=0.921 (35 df), hence in the absence of facilities for the automatic analysis of reducing sugars, measuring the refractive index of sap prepared in this way can give a good guide to the sugar levels in the sample. Sap prepared after the tissue had been disintegrated by a high-speed macerator was little different from freeze-thaw sap (r=0.937, 13 df).

Conclusion

Refractive index measurements using a high quality refractometer that has been calibrated and for which temperature compensation has been applied (refractive index varies considerably with temperature) provide a fairly reliable guide to the total soluble solids content of tomato sap. The soluble solids content is highly correlated with the sugar levels. But the method whereby the sap is

obtained from the fruit is crucial; it is not sufficient to break up the fruit by hand, let alone cut a single fruit in half and use the free sap from the locules. The whole fruit must be thoroughly disintegrated either with a macerator or by freezing and thawing the tissue.

4.2 The effects of grading on tomato fruit quality

Introduction

Tomato fruit have to be picked, transported to the grader and unloaded onto the machinery maybe washed and/or cooled before being colour and weight sorted into various combinations of ripeness and size. Several recent studies have indicated significant erosion of the shelf life of tomatoes that have come through normal channels of grading and distribution, and it was decided to try to quantify the extent of the damage that was being inflicted.

Materials and methods

Fruit of the cv Criterium was used grown commercially for experimental purposes at IHR, Littlehampton. A 'grading simulator' or 'conditioning machine' of Dutch design was used to stress fruit, picked at the commercial picking stage, in a reasonably reproducable way (see Figure 4.4). Batches of 20 fruit for each treatment were held for 5 days at 20°C, and the firmness (see Annual Report of the GCRI for 1986-7, pp. 120-125) and colour (Hunter Colormeter D25A-9) measured. On five occasions, the condition of the batches of fruit were assessed independently by ranking by appearance. Those in best condition were given a mark of 'one', the next 'two' and the worst 'three'. After considerable experimentation, it was decided to measure ethylene emanation on day 1 after treatment, and CO_2 production on day 2, both gases being estimated by gas chromatography.

Fruit from the same block of plants were compared after one of three treatments: (a) carefully picked, hand graded, (b) sampled after grading in the GCRI packhouse, and (c) put through the conditioning apparatus.

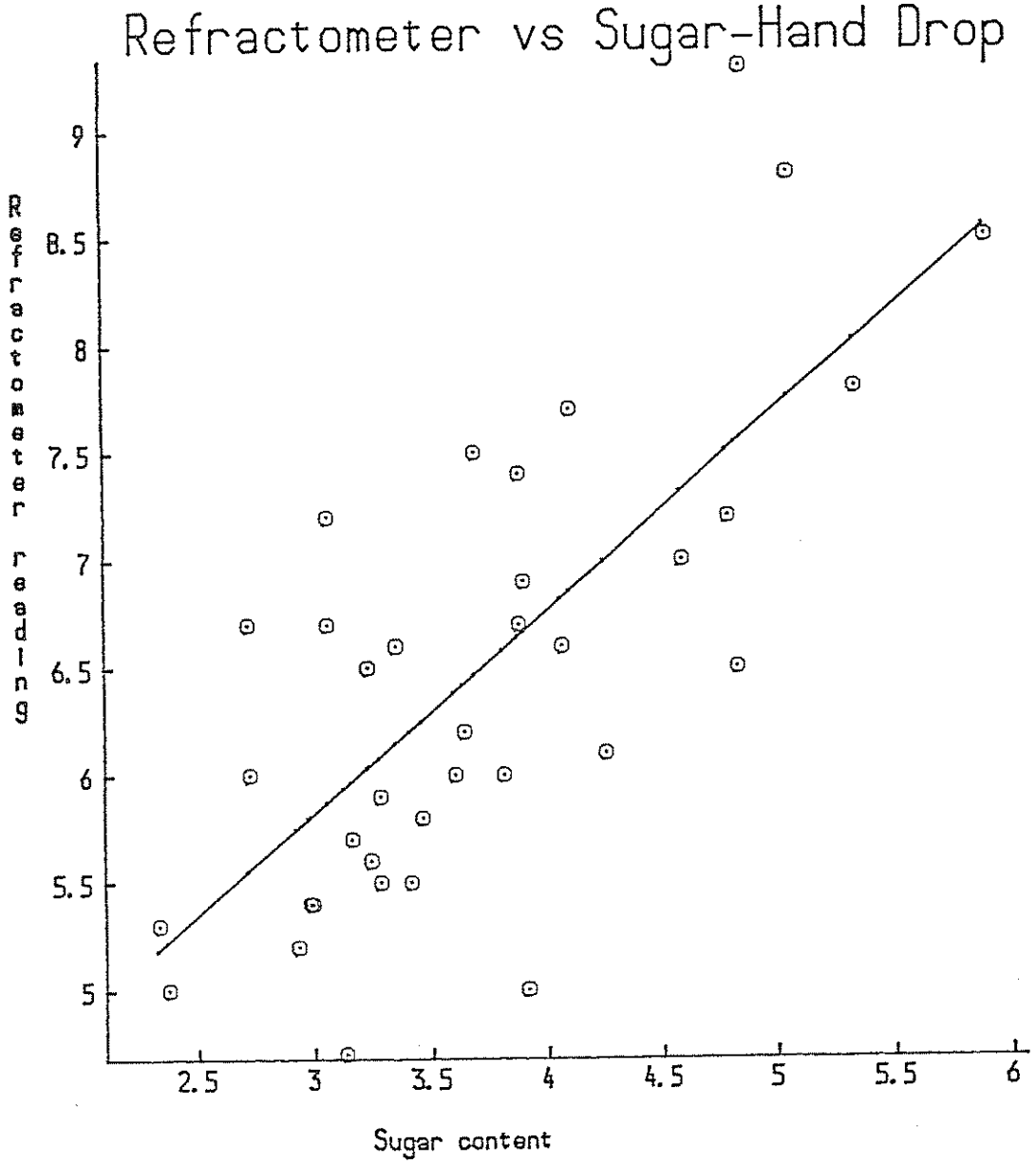
Results and discussion

Typical results for firmness assessments (measured as mm depression) together with colour data are given in Figure 4.5. The Colour Index measurements indicate that fruit from each of the treatments were very similar in hue after five days storage, although it is not easy to colour-match fruit from two different sources (direct from the glasshouse and from the packing shed). Although full statistical analysis has not been carried out on the firmness data, it is evident from Figure 4.5 that the control fruit were the firmest, followed by conditioned and then packing shed fruit. Ethylene production from conditioned fruit was slightly higher than from packing shed tomatoes, but both were very much higher than for control samples (Figure 4.6). Carbon dioxide evolution was very variable (Figure 4.7), and while the conditioned fruit gave off an above average amount of the gas, the differences between any of the treatments were not statisically valid. Storage assessments five or six days after treatment clearly showed (Figure 4.8) that the control fruit survived best followed by the conditioned fruit and then the packing shed samples.

Conclusion

Previous work on six nurseries has shown that tomatoes picked carefully and sorted by hand in the glasshouse have an average shelf life of 11.9 days, in contrast to similar fruit handled normally having a product-life of 6.9 days (a 42% reduction). The present results indicate that physiological damage is sustained by ripening tomatoes during grading and grading-simulation ('conditioning') in terms of a loss of firmness, increased production of ethylene and erosion of shelf life. The sensitivity of tomatoes to mechanical shock is underlined by the significant responses shown by fruit given a single heavy impact followed by a few smaller jolts. Any mechanical stresses that can be eliminated during the handling of tomatoes will be reflected in an extension of the product life of the fruit. It is hoped that an 'electronic tomato' will become available towards the end of 1988 to allow further information to be gathered.

Fig 4.1

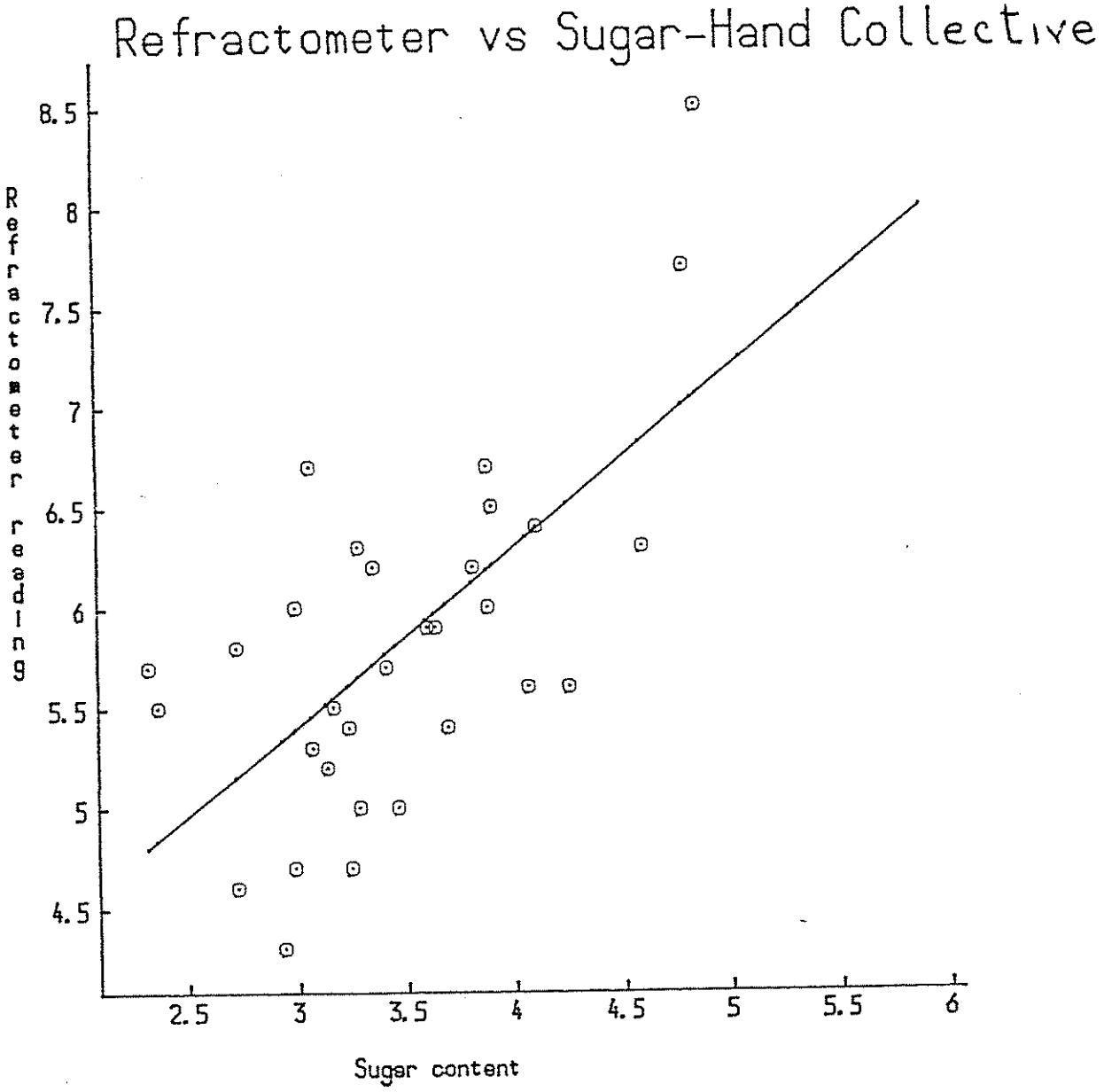


Refractometer vs Sugar-Hand Drop

——— Fitted r=0.651 d.f.=31

⊙ ⊙ Recorded

Fig 4.2



Refractometer vs Sugar-Hand Coll

Fitted r=0.722, d. f=29

Recorded

Fig 1.3.2

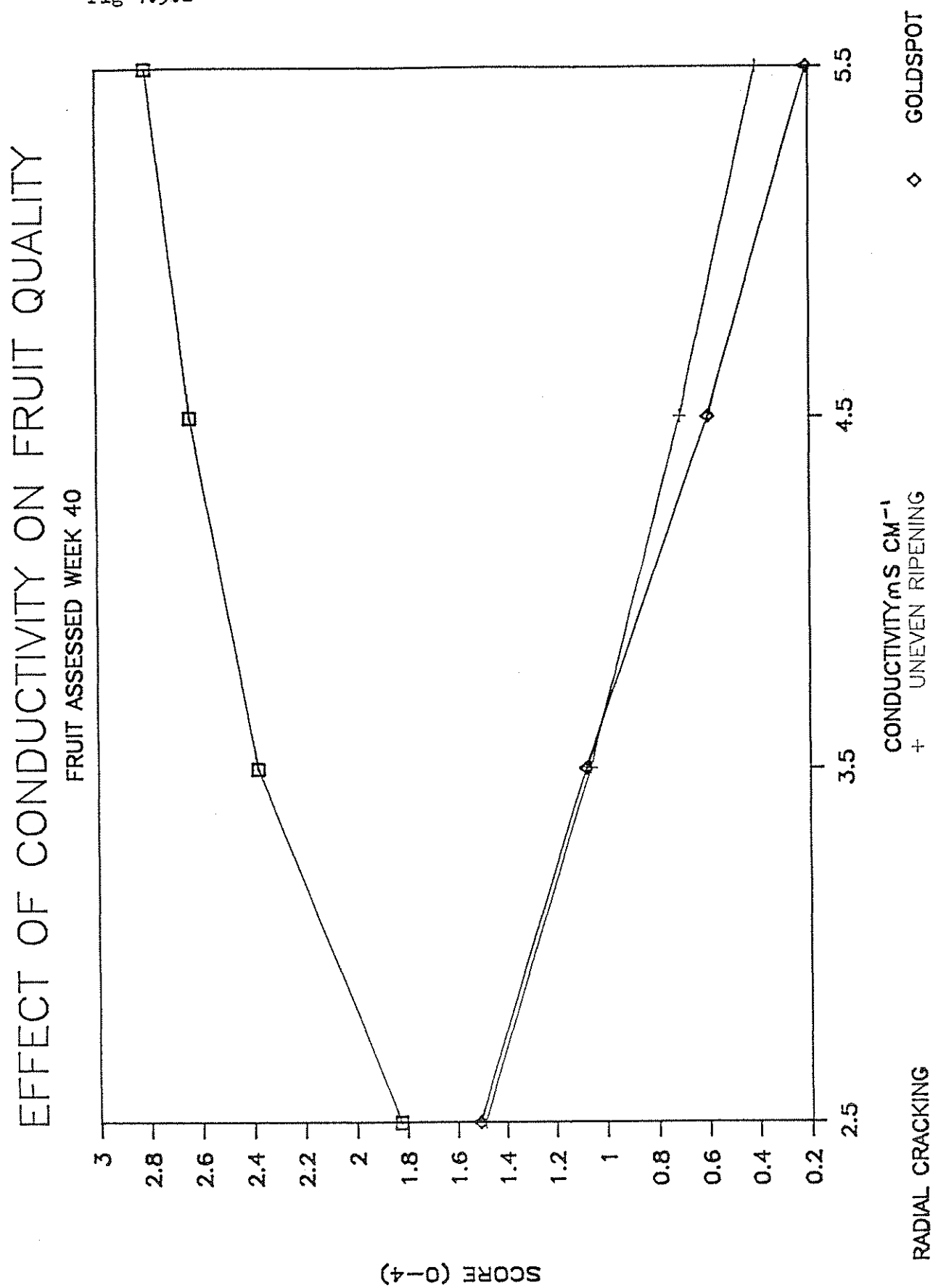
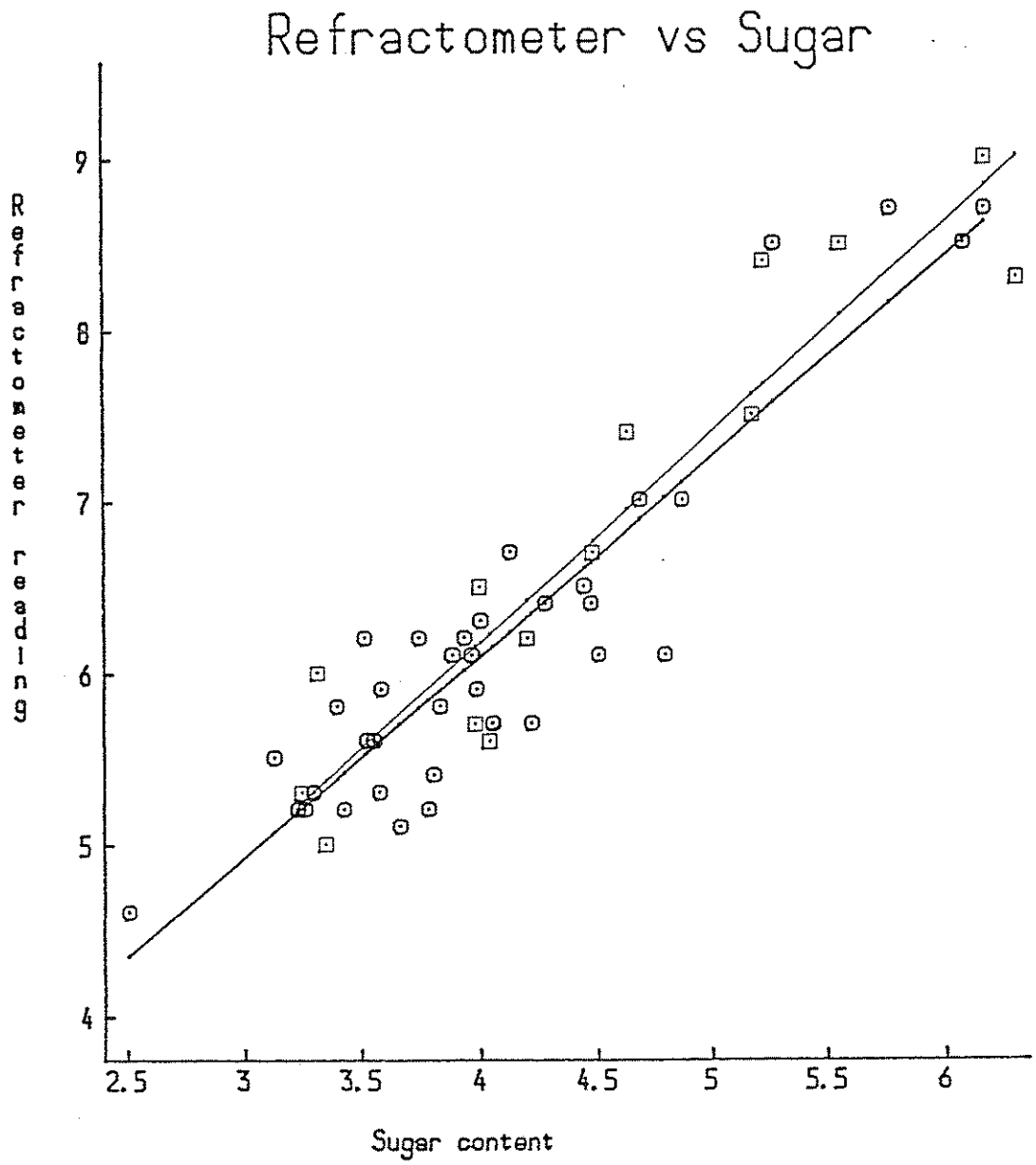

EFFECT OF CONDUCTIVITY ON FRUIT QUALITY
FRUIT ASSESSED WEEK 40
SCORE (0–4)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
2.5
3.5
4.5
5.5
CONDUCTIVITY mS CM⁻¹
RADIAL CRACKING
+ UNEVEN RIPENING
◇ GOLDSPOT

Fig 4.3



Refractometer vs Sugar

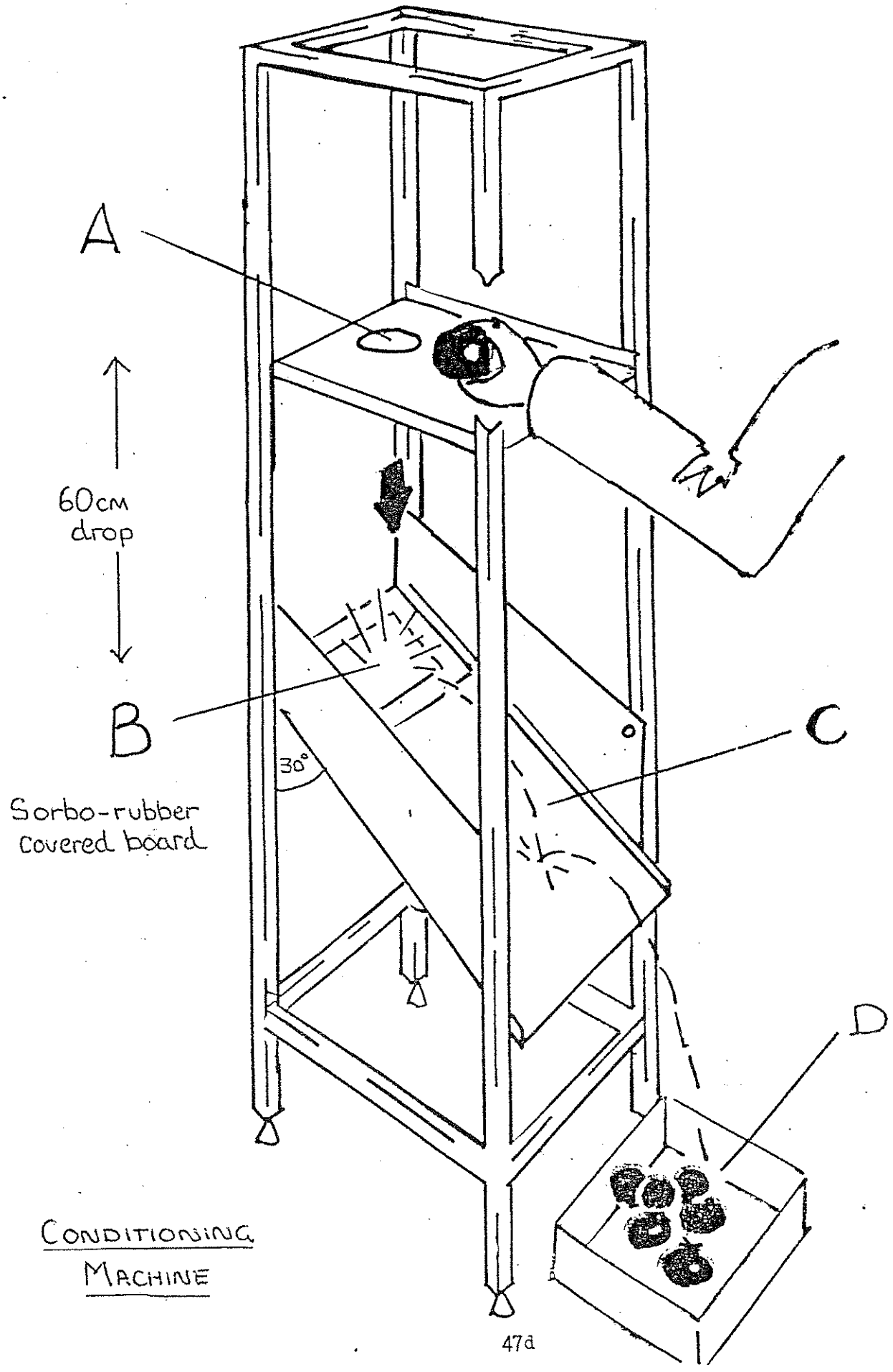
Freeze r=.921 d.f.=35

Macerate r=0.937 d.f.=13

Rec freeze

Rec Macerate

Fig 4.4



CONDITIONING MACHINE

Fig 4.5

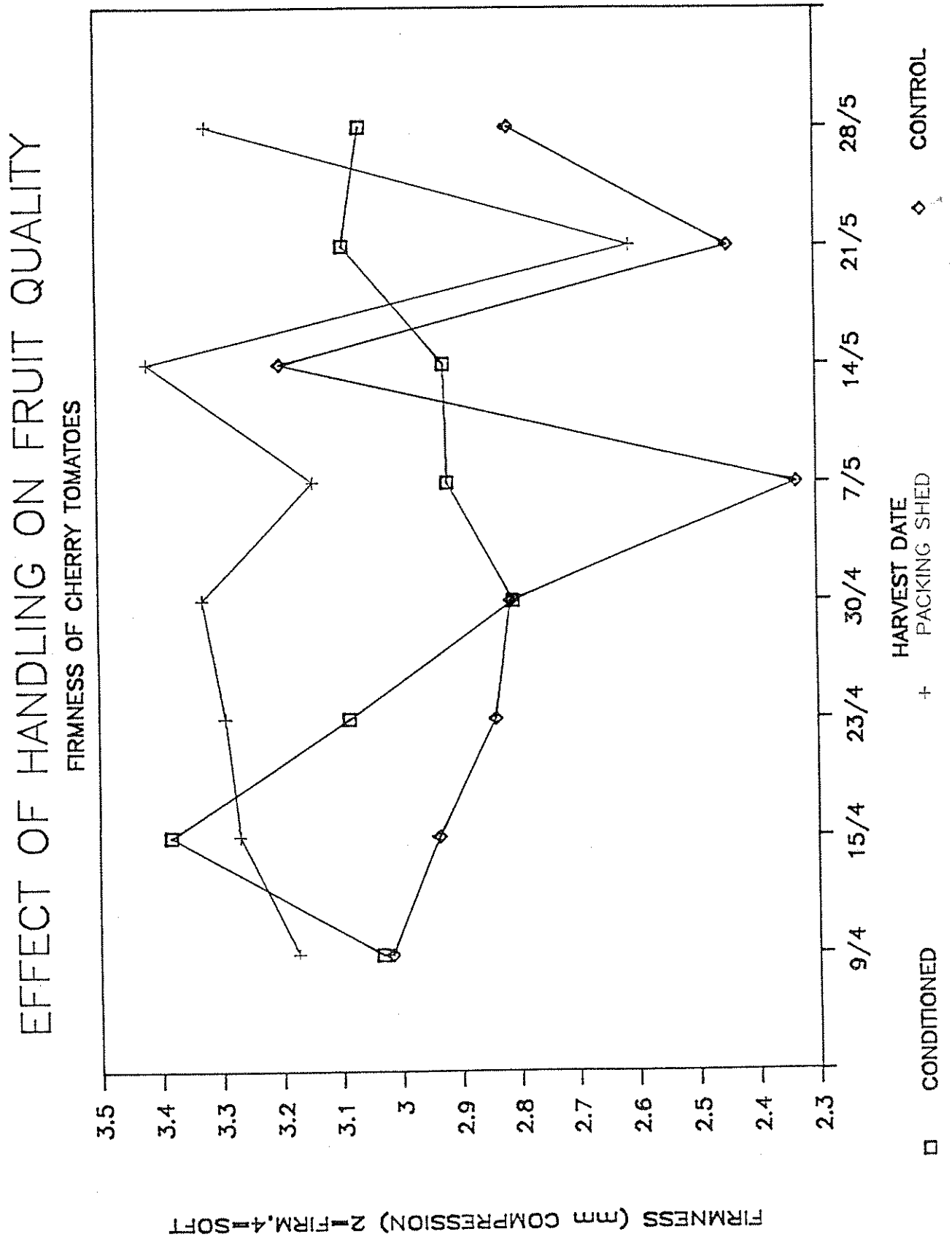

EFFECT OF HANDLING ON FRUIT QUALITY
FIRMNESS OF CHERRY TOMATOES
FIRMNESS (mm COMPRESSION) 2=FIRM,4=SOFT
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
9/4
15/4
23/4
30/4
7/5
14/5
21/5
28/5
HARVEST DATE
PACKING SHED
CONDITIONED
CONTROL

Fig 4.6

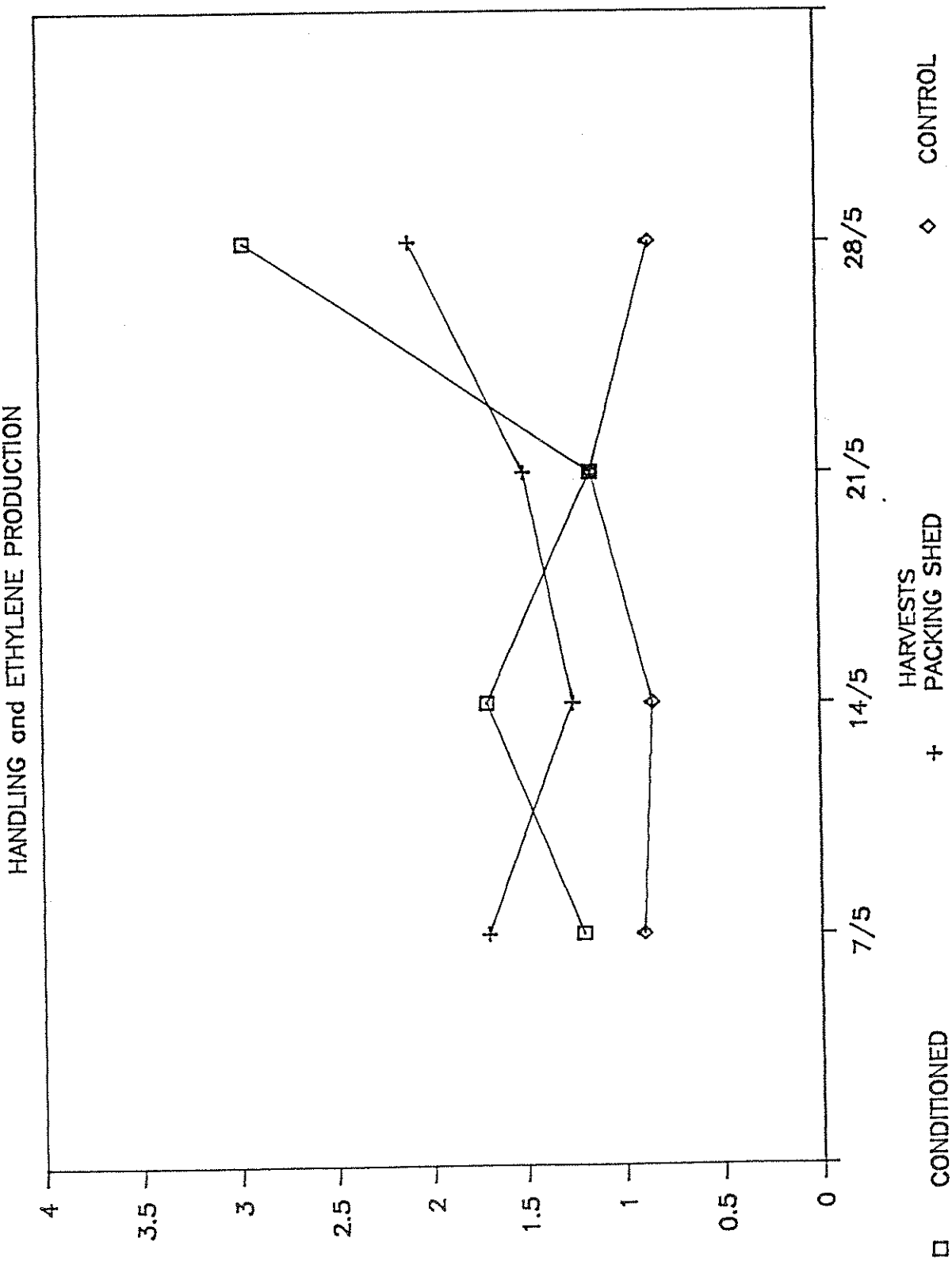

HANDLING and ETHYLENE PRODUCTION
C_2H_4 v.p.m. per 100gms fruit
4
3.5
3
2.5
2
1.5
1
0.5
0
7/5
14/5
21/5
28/5
HARVESTS
PACKING SHED
CONDITIONED
CONTROL

Fig 4.7

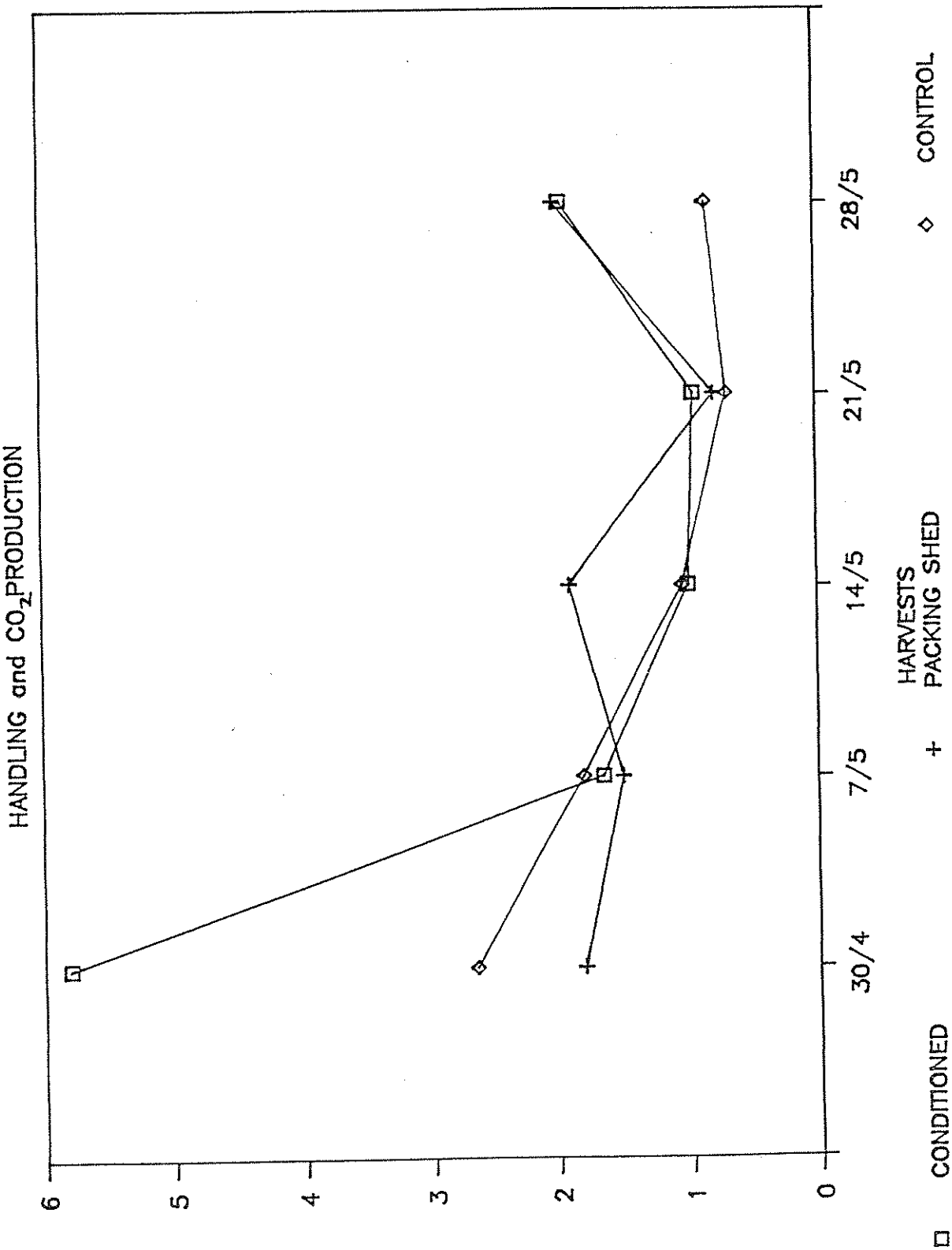
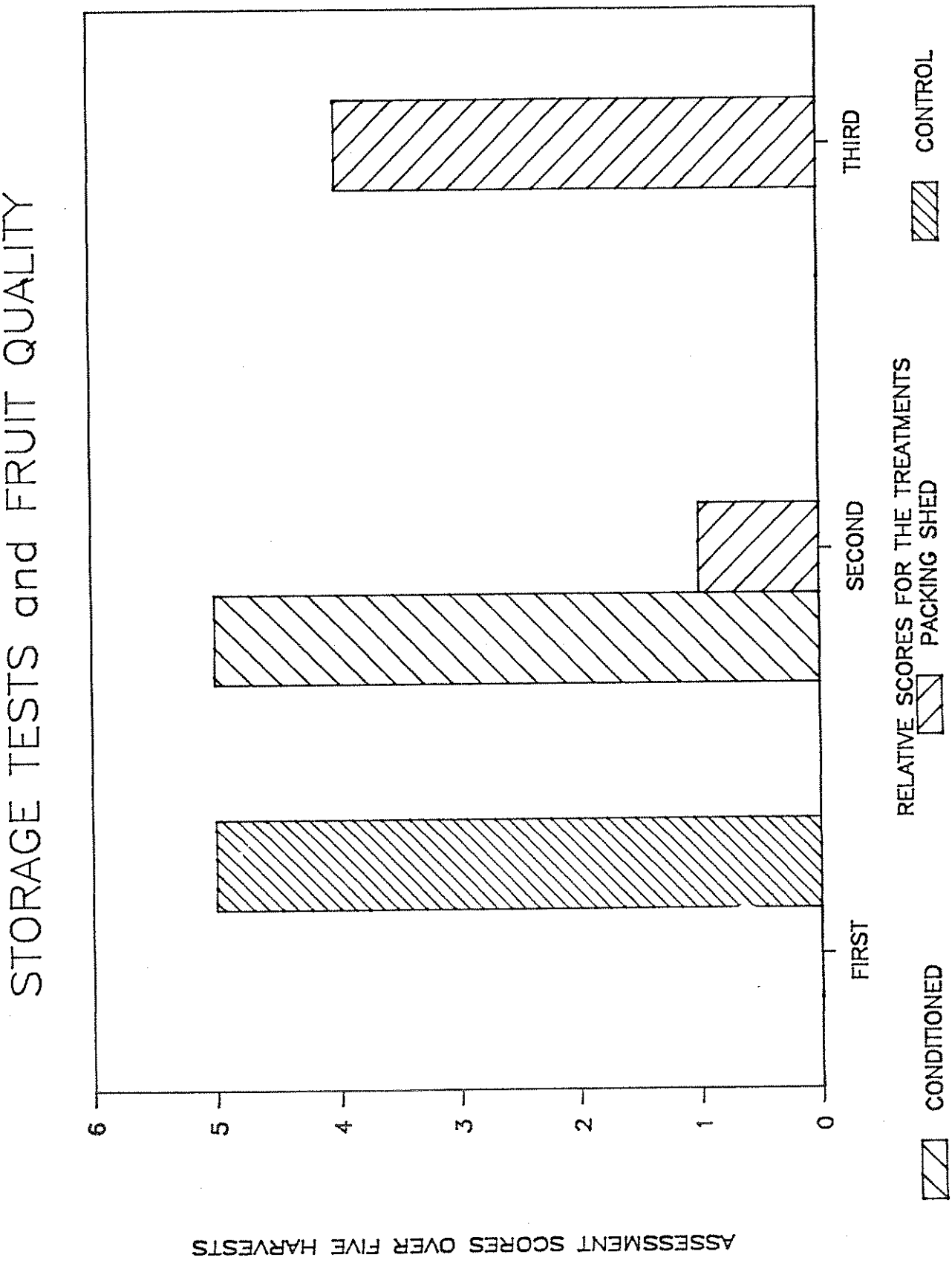

HANDLING and CO_2 PRODUCTION
% CO_2 per 100gms fruit (Day 1)
0
1
2
3
4
5
6
30/4
7/5
14/5
21/5
28/5
HARVESTS
PACKING SHED
CONDITIONED
CONTROL

Fig 4.8


STORAGE TESTS and FRUIT QUALITY
ASSESSMENT SCORES OVER FIVE HARVESTS
0
1
2
3
4
5
6
FIRST
SECOND
THIRD
RELATIVE SCORES FOR THE TREATMENTS
PACKING SHED
CONDITIONED
CONTROL

Standardised assessment of tomato fruit quality

The three assessments covered are:

1. Product life
2. Chemical composition
3. Physical characteristics.

1. Product life (6 day test)

1.1 Sample: Minimum fruit number of 20 to be harvested on a Wednesday and taken bulked from all replicates, calyx retained, Class I fruit. Modal size group (usually D's but dependent on variety), ripeness stage 2 (ATB).

1.2 Handling: Fruit to be collected from the packhouse pre-grading and to be passed through the handling simulator (Fig.1) from a height of 50 cm.

1.3 Product life room temp: 20°C, RH to be measured as that achieved at Efford and Stockbridge House and reproduced at Luddington. Fluorescent lighting 12 hrs day. No direct sunlight.

1.4 Records:

1.4.1 Colour stage of each fruit using the ATB scale, three times (Wednesday, Friday, Tuesday).

1.4.2 Bulk weight three times (Wednesday, Friday, Tuesday).

1.4.3 Firmness of 20 fruit six days post harvesting using the compression tester (under 1 kg weight). This test is considered destructive.

1.4.4 Where possible additional fruit to be retained to assess the number of fruit still considered edible after 6 and 12 days. This assessment to be made on the basis of whether each fruit was acceptable to be eaten by a consumer on the day of assessment

1.6 Product life (12 day test)

When harvesting permits an additional sample of minimum 20 fruit to be taken and product life assessments will be extended to span a 12 day period.

1.5.1 As previously described fruit to be harvested on Wednesday.

1.5.2 Colour assessments and bulk weights to be taken 5 times (Wednesday, Friday, Tuesday, Friday, Tuesday).

1.5.3 Compression testing on the 12th day.

2. Chemical composition

2.1 Sampling: Use the sample of 20 fruit compression tested after six days.

2.2 Juice extraction: Cut each fruit in half and place one half of each fruit in a strong polythene bag. (This should produce approximately 400g of fruit).

2.2.1 Seal bag securely using a heat sealer or stapler.

2.2.2 Freeze overnight in a domestic deep freeze.

2.2.3 Thaw overnight in a fridge and finish using a little hot water the following morning.

2.2.4 Wrap fruit in 2 layers of muslin and press in a fruit press.

2.2.5 Collect juice and centrifuge if possible

2.2.6 Filter through glasswool.

2.3 % soluble solids: Determine % soluble solids (Brix) with a 0-10% hand held refractometer at 20°C.

2.4 Acidity: Dissolve 1.9g of sodium phosphate ($Na_3 PO_4.12 H_2O$) into 100 ml sample of extracted tomato sap and measure the resulting pH using a previously calibrated pH meter.

This indirect acidity measurement has been found to give results closely correlated to the more accurate titration method (Hobson & Kilby 1984).

Hobson G & Kilby P Rapid assessment of tomato composition during high quality fruit production and distribution. Acta Horticulturae 163 (1984), pp 47-54.

All titratable acidity figures quoted were obtained from the pH measurements in this way. For conversion % citric acid multiply by 0.064.

2.5 Percentage dry matter

2.5.1 Take small samples from the remaining halves of compression tested fruit to make up a 100g sample (including a representative sample of juice).

2.5.2 Dry in an oven for 48 hours at 80 °C.

2.5.3 Cool in a desiccator.

2.5.4 Re-weigh sample and calculate % dry matter.

2.6 Juice analysis (carried out at IHR)

Samples of juice from every nth composition test (depending on time and resources) to be stored in a domestic freezer in a polythene bottle and to be analysed at IHR to establish the relationship between % Brix and concentration of reducing sugars present in fruit (see pp 44-47).

Physical characteristics

3. Scoring systems used for tomato fruit characteristics/disorders

A sample (20 fruit minimum where possible) were taken at random from ungraded fruit. Every replicate was recorded where possible.

Scoring system: 5-part scale, 0-4. In most cases the scores will be

0 - none
1 - very slight
2 - slight
3 - moderate
4 - severe.

Ribbing

The extent to which raised shoulders of 'ribs' are present at the calyx end of the fruit.

0 - none present, shoulder smooth
1 -
2 -
3 -
4 - shoulders severely raised and ribs prominent.

Boxiness

The extent to which the total fruit surface area is flattened or angular:

0 - none, fruit spherical
1 -
2 -
3 -
4 - more than 75% of fruit surface area flattened to a single plane.

Nippling

The formation of a small protrusion or 'nipple' at the blossom end of the fruit:

0 - none

1 -

2 -

3 -

4 - nipple prominent, in danger of being damaged and/or damaging other fruit during handling and packing, i.e.

Fine net cracking

This is a measure of the very fine net cracking or crazing which has been particularly evident on early crops:

0 - none present

1 - up to 25% of surface area

2 - " " 50% " " "

3 - " " 75% " " "

4 - more than 75% of fruit surface area affected.

Radial cracking

The traditional sealed cracks which can be formed radially around the calyx late in fruit development:

0 - none present

1 - up to $\frac{1}{4}$ of fruit circumference covered in a few large cracks or several smaller cracks

2 - up to $\frac{1}{2}$ fruit circumference affected

3 - up to $\frac{3}{4}$ " " "

4 - more than $\frac{3}{4}$ fruit " "

Uneven ripening

The extent of severe differences in skin colour on a single tomato. The traditional pattern of ripening in which the shoulder and calyx end lag slightly behind the rest of the fruit is to be scored as normal (i.e. 0):

0 - none

1 -

2 -

3 -

4 - more than 50% of fruit surface is at least 2 ATB colour stages different from the rest.

Goldspot

The extent to which a fine peppery gold spot covers the fruit surface:

0 - very little present (no more than 5% surface area affected)

1 - up to 20% of surface area affected around calyx

2 - " " 50% " " " " " "

3 - " " 75% " " " " " "

4 severe spotting covering more than 75% of fruit surface.

Flecking

A measure of the whitish streaks often found down the side of fruit and around the blossom end:

0 - very little present

1 -

2 -

3 -

4 - severe, covering more than 40% of surface area.

Fruit shape

The extent to which the fruit varies from spherical:

0 - flat

1 -

2 - spherical

3 -

4 - long

Splitting

The extent to which a fruit is subject to open splits:

0 - none present

1 -

2 -

3 -

4 - severe at least one split extending around circumference of fruit.

Ghost spot

A measure of the extent of ghost spotting blemishes present on the fruit surface:

0 - none present

1 - very slight (1 or 2 small isolated spots)

2 - slight, (up to 4 small isolated spots)

3 - moderate, (up to 6 " " ")

4 - severe, (more than 7 small " ")

Efford EHS

Variety trial. P-Block Product life

Table 1 Fruit firmness. % compression after 6 days

Variety	Week 14	Week 17	Week 22	Week 26	Week 30	Week 34	Mean
A: Calypso	9.9	6.5	8.2	7.4	8.0	6.8	7.80
B: Counter	9.9	6.5	7.4	7.6	8.4	6.8	7.77
C: Criterium	9.9	6.3	6.8	6.8	7.4	5.8	7.17
D Marcella	9.3	6.8	7.5	7.6	7.1	6.5	7.47
F: Mercator	8.5	6.5	7.6	7.3	7.3	6.4	7.27
H: Turbo	10.5	6.8	8.0	7.8	8.2	6.6	7.98
J: 662	9.5	7.4	7.8	7.5	7.5	6.6	7.72
K: 663	9.9	6.4	8.0	7.2	7.8	6.4	7.62
L: W690	8.9	7.4	8.1	7.9	8.1	6.2	7.77
N: W704	8.5	5.8	7.7	6.3	7.1	5.8	6.87
Ob	9.2	7.0	6.7	6.3	7.2	6.1	7.08
P: 2015	9.4	7.1	7.7	7.3	7.7	6.1	7.55
Mean	9.45	6.71	7.63	7.25	7.65	6.34	7.50

Efford EHS

Variety trial, P-Block Product life

Table 2 Fruit firmness, % compression after 13 days (*: after 14 days)

Variety	Week 14	Week 17	Week 22	Week 26	Week 30	Week 34*	Mean
A: Calypso	13.1	8.7	10.5	10.5	11.4	8.7	10.48
B: Counter	12.2	8.3	9.7	11.3	12.2	9.5	10.53
C: Criterium	13.4	8.5	8.3	10.3	11.8	7.9	10.03
D: Marcella	11.5	8.2	10.5	10.0	10.4	8.8	9.90
F: Mercator	12.8	8.9	9.6	11.2	11.7	10.0	10.70
H: Turbo	11.4	8.7	9.1	11.4	12.0	9.3	10.32
J: 662	12.1	9.3	10.3	10.8	10.7	9.4	10.43
K: 663	11.6	8.5	9.5	10.4	11.4	9.2	10.10
L: W690	10.7	9.3	10.4	11.1	10.9	9.3	10.28
N: W704	11.2	8.2	9.0	10.1	9.5	8.3	9.38
Ob	12.7	8.9	8.3	10.3	10.8	9.1	10.02
P: 2015	10.9	8.8	10.3	9.9	10.6	7.5	9.67
Mean	11.97	8.69	9.63	10.61	11.12	8.92	10.15

Efford EHS

Variety trial, P-Block Product life

Table 3 Percentage uneatable after 12 days

Variety	Week 14	Week 17	Week 22	Week 26	Week 30	Week 34	Mean
A: Calypso		83	65	50	88	30	63
B: Counter		79	25	40	100	25	54
C: Criterium		86	47	50	100	25	62
D: Marcella		72	35	21	67	44	48
F: Mercator		87	50	100	100	68	81
H: Turbo		64	15	81	93	28	56
J: 662		94	65	55	82	74	74
K: 663		73	30	20	80	40	49
L: W690		93	65	31	92	39	64
N: W704		93	55	59	68	50	65
Ob		88	30	42	67	31	52
P: 2015		67	60	25	71	6	46
Mean		82	45	48	84	38	59

Efford EHS

Variety trial, P-Block Product life

Table 5 % fruit weight, after 12 days (weight at picking = 100%)

Variety	Week 14	Week 17	Week 22*	Week 26	Week 30	Week 34	Mean
A: Calypso	84.3	89.1	90.2	90.1	89.9	92.5	89.35
B Counter	87.2	89.8	93.8	90.3	90.7	92.4	90.70
C: Criterium	84.7	87.8	91.6	88.8	89.1	92.4	89.07
D: Marcella	85.8	89.5	92.3	90.5	92.2	91.4	90.28
F: Mercator	84.2	88.6	90.9	88.5	90.9	93.0	89.35
H: Turbo	87.1	89.4	93.5	88.5	88.4	92.3	89.87
J: 662	84.3	87.6	88.8	87.0	88.3	89.4	87.57
K: 663	84.8	88.6	92.2	90.1	89.1	90.9	89.28
L: W690	89.2	88.5	91.3	90.3	91.4	93.4	90.68
N: W704	86.1	89.8	90.1	89.2	90.9	92.4	89.75
Ob	85.8	87.4	93.9	91.5	91.0	93.6	90.53
P: 2015	87.6	89.0	89.7	90.8	91.6	94.2	90.48
Mean	85.93	88.76	91.53	89.63	90.29	92.33	89.74

*after 11 days

Efford EHS

Variety trial, P-Block Product life

Table 4 % fruit weight, after 6 days (weight at picking=100%)

Variety	Week 14	Week 17	Week 22*	Week 26	Week 30	Week 34	Mean
A: Calypso	90.4	92.9	95.4	95.2	94.5	95.6	94.00
B: Counter	91.8	93.3	96.9	95.0	95.0	96.0	94.67
C: Criterium	90.0	92.8	95.4	94.2	94.3	95.6	93.72
D: Marcella	92.4	93.9	96.5	95.2	95.7	95.4	94.85
F: Mercator	92.0	93.6	94.0	94.7	95.0	96.1	94.23
H: Turbo	91.6	93.3	96.5	94.5	93.9	95.6	94.23
J: 662	90.3	92.5	93.7	92.9	94.1	94.7	93.03
K: 663	90.4	92.4	95.8	94.7	94.2	95.1	93.77
L: W690	92.2	93.8	95.3	94.9	95.6	96.5	94.72
N: W704	92.0	93.6	94.3	94.8	95.6	96.3	94.43
Ob	92.1	92.0	96.6	95.4	96.7	96.9	94.95
P: 2015	92.1	93.4	95.2	95.5	95.5	96.7	94.73
Mean	91 44	93.13	95.47	94.75	95.01	95.88	94.28

*after 5 days

Efford EHS

Variety trial, P-Block Chemical composition

Table 6 % soluble solids content of fruit (Temperature corrected)

Variety	Week 14	Week 17	Week 22	Week 26	Week 30	Week 34	Mean
A: Calypso	4.8	4.7	4.6	4.9	5.4	5.6	5.00
B Counter	4.5	4.2	4.4	5.0	5.2	5.0	4.72
C: Criterium	4.8	4.2	4.4	4.9	5.4	4.9	4.77
D: Marcella	4.7	4.5	4.5	4.9	5.1	5.2	4.82
F: Mercator	4.6	4.1	4.4	4.7	5.1	4.9	4.63
H: Turbo	4.9	4.5	4.5	5.2	5.2	5.2	4.92
J: 662	5.0	4.6	4.7	5.4	5.3	5.5	5.08
K: 663	5.2	4.5	4.2	5.3	5.3	5.5	5.00
L: W690	4.8	4.4	4.6	5.1	5.4	5.4	4.95
N: W704	4.7	4.3	4.6	4.8	5.3	5.2	4.82
Ob	4.6	4.6	4.5	4.8	4.9	5.1	4.75
P: 2015	4.7	4.4	4.7	5.0	5.2	5.4	4.90
Mean	4.78	4.42	4.51	5.00	5.23	5.24	4.86

Efford EHS

Variety trial, P-Block Chemical composition

Table 7 Acidity (mEq/100 ml)

Variety	Week 14	Week 17	Week 22	Week 26	Week 30	Week 34	Mean
A: Calypso	8.7	8.7	7.1	7.6	7.8	7.6	7.92
B: Counter	7.6	5.6	6.5	7.1	6.7	5.6	6.52
C: Criterium	6.9	6.0	5.9	6.4	6.2	5.1	6.08
D Marcella		6.5	5.9	7.1	5.9	5.5	6.18
F: Mercator	8.1	7.4	6.7	5.9	6.9	5.2	6.70
H: Turbo	9.0	6.5	6.9	7.4	7.1	6.0	7.15
J: 662	9.4	7.6	7.4	7.8	7.1	6.4	7.62
K: 663	9.0	7.4	7.6	7.6	6.9	6.9	7.57
L: W690	8.7	6.4	7.4	7.6	7.6	7.4	7.52
N: W704	8.4	5.3	6.5	7.6	7.6	6.2	6.93
Ob		4.1	6.7	6.0	5.8	5.6	5.64
P: 2015	9.0	4.7	6.0	7.6	6.7	6.5	6.75
Mean	8.48	6.35	6.72	7.14	6.95	6.17	

Efford EHS

Variety trial P-Block Physical appearance

Table 8 Ribbing score (0-4)

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso	.45	.90	.20	.30	0	.37
B: Counter (Control)	.65	1.00	.30	.10	.15	.44
C: Criterium	1.05	1.35	.65*	.25	.15	.69
D: Marcella	.50	.65	.25	.10	.10	.32
F: Mercator	.55	.95	.55	.15	.15	.47
H: Turbo	.60	.90	.35	.05	.05	.39
J: 662	.30	.65	.10	.10	0	.23
K: 663	.65	.75	.25	.05	.05	.35
L: W690	.30	.85	.45	.10	.05	.35
N: W704	80	.85	.20	.05	0	.38
Ob	.60	1.00	.70*	.05	.10	.49
P: 2015	.45	.85	.15	.20	0	.33
Mean	.575	.892	.346	.125	.067	.40
SED	.183	.234	.155	.149	.099	
LSD	-	-	.341	-	-	
Signific. (sig. at P=0.06)	ns	ns	*	ns	ns	

*sig. diff from control variety (Counter) at 5% level.

Efford EHS

Variety trial. P-Block Physical appearance

Table 9 Boxiness score (0-4)

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso	0	.05	.10	0*	0	.03
B: Counter (Control)	.15	.15	.25	.55	.10	.24
C: Criterium	.15	.10	.30	1.00*	0	.13
D: Marcella	.05	.25	.05	.60	.15	.22
F: Mercator	.25	0	.10	.15*	0	.10
H: Turbo	.10	0	.20	.15*	.10	.11
J: 662	0	0	0	.20*	0	.04
K: 663	0	.05	.35	.20*	.05	.13
L: W690	.05	0	0	.45	.10	.12
N: W704	0	.30	.40	.40	.65***	.35
Ob	.10	0	.10	.65	.05	.18
P: 2015	.05	.05	0	.15*	.10	07
Mean	.075	.079	.154	.300	.108	.14
SED	.122	.106	.200	.155	.088	
LSD	-	-	-	.340	.390	
Signific.	ns	ns	ns	*	***	

* sig. diff from control variety (Counter) at 5% level

*** " " " " " " " 0.1% "

Efford EHS

Variety trial, P-Block Physical appearance

Table 10 Nippling score (0-4)

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso	.35	0	.25	.45	.65	.34
B: Counter (Control)	.60	.10	.35	.15	.55	.35
C: Criterium	.40	.20	.05	.50	.65	.36
D: Marcella	.85	.10	.50	.95	1.00*	.68
F Mercator	.40	.15	.20	.55	.95	.45
H: Turbo	.65	.05	.20	.70	.85	.49
J: 662	.45	.05	.60	.65	.70	.49
K: 663	.50	.35	.25	.50	.70	.46
L: W690	.30	.20	.05	.85	1.35**	.55
N: W704	.20	0	.05	.55	.70	.30
Ob	.70	.30	.30	.45	.25	.40
P: 2015	.15	.05	0	.10	.10*	.08
Mean	.463	.129	.233	.533	.704	.41
SED	.221	.102	.218	.289	.192	
LSD	-	-	-	-	**0.595 *0.4219	
Signific.	ns	ns (sig. at P=0.07)	ns	ns	**	

* sig. diff from control variety (Counter) at 5% level

** " " " " " " 1% "

Efford EHS

Variety trial, P-Block Physical appearance

Table 11 Fine net cracking score (0-4)

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso	3.30	.55	.65	.25	1.00	1.15
B: Counter (Control)	3.20	.25	.75	0	.90	1.02
C: Criterium	3.40	.85	1.40	.65	.90	1.44
D: Marcella	2.40	.15	.70	.10	.40	.75
F Mercator	1.40***	.20	.70	.45	1.15	.78
H: Turbo	2.55	.50	0*	.05	.65	.75
J: 662	3.75	.75	1.95*	1.35	2.00	1.96
K: 663	3.05	.45	.65	.90	2.00	1.41
L: W690	3.60	.75	.50	.10	1.50	1.29
N: W704	3.40	.20	.85	1.00	1.55	1.40
Ob	1.90**	.55	1.15	.85	1.40	1.17
P: 2015	3.70	.40	.45	.15	.70	1.08
Mean	2.971	.467	.813	.488	1.180	1.18
SED	.271	.339	.335	.426	.597	
LSD	1.646	-	.737	-	-	
Signific.	***	ns	* (sig. at P=0.10)	ns	ns	

* sig. diff from control variety (Counter) at 5% level

** " " " " " " 1% "

*** " " " " " " 0.1% "

Efford EHS

Variety trial, P-Block Physical appearance

Table 12 Radial cracking score (0-4)

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso	0	.20	.35	.85	.85*	.45
B: Counter (Control)	0	0	.70	.55	2.20	.69
C: Criterium	0	.20	.85	1.20	1.15	.68
D: Marcella	0	0	.65	.35	1.25	.45
F Mercator	0	0	.65	1.15	2.00	.76
H; Turbo	0	.10	.20	.55	1.35	.44
J: 662	0	.20	1.40	1.70	2.45	1.15
K: 663	0	0	.45	1.10	2.40	.79
L: W690	0	.05	.55	.55	1.65	.56
N: W704	0	.05	1.15	1.25	1.80	.85
Ob	0	0	1.10	1.15	2.20	.89
P: 2015	0	.10	.35	.75	.75*	.39
Mean		.075	.70	.929	1.670	.68
SED		.090	.356	.355	.485	
LSD		-	-	-	1.068	
Signific.		ns	ns (sig. at P=0.08)	ns	*	

*sig diff from control variety (Counter) at 5% level

Efford EHS

Variety trial, P-Block Physical appearance

Table 13 Uneven ripening score (0-4)

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso	0	.55	.45	.85	.65*	.50
B Counter (Control)	0	.10	.85	1.15	1.35	.69
C: Criterium	0	.15	.65	.80	1.00	.52
D: Marcella	.10	.25	1.05	1.05	1.45	.78
F: Mercator	0	.20	.50	.65	1.40	.55
H: Turbo	0	.15	.75	.75	.80*	.49
J: 662	0	.25	.65	.60	.70*	.44
K: 663	.05	.05	.90	.65	1.45	.62
L: W690	0	.35	.95	.90	.80*	.60
N: W704	0	.30	.25	.90	1.35	.56
Ob	.05	.15	.60	.65	1.70	.63
P: 2015	0	.25	.55	1.00	1.05	.57
Mean	.017	.229	.679	.829	1.142	.58
SED	.046	.145	.307	.270	.243	
LSD	-	-	-	-	.534	
Signific.	ns	ns	ns	ns	*	

*sig. diff from control variety (Counter) at 5% level

Efford EHS

Variety trial, P-Block Physical appearance

Table 14 Gold spots score (0-4)

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso	1.00	.15	.50	.60	.15	.48
B: Counter (Control)	1.45	.45	1.00	1.45	1.15	1.10
C: Criterium	.95	.50	.40	1.30	.65	.76
D: Marcella	1.60	.35	.50	.75	.55	.75
F: Mercator	.70	.15	.20	.70	.10	.37
H: Turbo	.95	.20	.35	.45	.45	.48
J: 662	1.80	.90	.10	.55	.05	.68
K: 663	1.30	.90	.45	.50	.30	.69
L: W690	.80	.45	.10	.75	.40	.50
N: W704	1.10	.85	.25	.80	.25	.65
Ob	1.70	.20	.40	1.40	.50	.84
P: 2015	1.05	.65	1.50	1.70	.40	1.06
Mean	1.20	.479	.479	.913	.413	.70
SED	.379	.323	.337	.407	0.345	
LSD	-	-	-	-	-	
Signific.	ns	ns	ns	ns	ns	
		(sig. at P=0.05)				

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Variety trial, P-Block Physical appearance

Table 15 Flecking score (0-4)

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso	.80	1.10	1.95	1.60	3.00	1.69
B: Counter (Control)	1.15	1.10	1.75	1.35	3.00	1.67
C: Criterium	1.05	1.20	1.65	1.20	2.90	1.60
D: Marcella	1.10	1.10	1.30	1.40	2.95	1.57
F: Mercator	.70	.90	1.45	1.45	2.80*	8.46
H: Turbo	1.15	1.10	2.00	1.35	2.95	1.71
J: 662	.95	1.15	1.95	1.65	3.00	1.74
K: 663	1.00	1.30	1.70	1.55	3.00	1.71
L: W690	1.15	1.25	2.50	1.80	2.95	1.93
N: W704	1.15	1.00	1.65	1.45	2.75*	1.60
Ob	1.10	1.30	1.75	1.60	2.80*	1.71
P: 2015	.95	1.00	2.00	1.75	2.90	1.72
Mean	1.021	1.125	1.804	1.513	2.917	1.68
SED	.199	.172	.362	.226	.074	
LSD	-	-	-	-	.162	
Signific.	ns	ns	ns	ns	*	

*sig. diff from control variety (Counter) at 5% level

Efford EHS

Variety trial, P-Block Physical appearance

Table 16 Shape score (0-4)*

Variety	Week 15	Week 19	Week 24	Week 28	Week 35	Mean
A: Calypso		2.00	1.90	2.05	2.00	1.99
B: Counter (Control)		2.10	1.95	2.15	2.00	2.05
C: Criterium		2.30	1.75	2.30	2.10	2.11
D: Marcella		2.00	2.15	2.10	2.15	2.10
F: Mercator		1.85	1.95	2.10	2.00	1.98
H: Turbo		1.90	1.80	2.00	2.00	1.93
J: 662		1.70	1.90	2.05	2.30	1.99
K: 663		1.95	1.75	2.15	2.00	1.96
L: W690		2.00	1.70	2.30	2.05	2.01
N: W704		1.95	1.80	2.05	2.05	1.96
Ob		2.10	1.90	2.20	2.10	2.08
P: 2015		2.05	2.15	2.40	2.05	2.16
Mean		1.992	1.892	2.154	2.067	2.03
SED		.158	.166	.119	.113	
LSD		-	-	-	-	
Signific		ns	ns	ns	ns	

*Where 2 = round 0 = flat, 4 = long

Efford EHS

Temperature regimes F-Block Product life

Table 17 Firmness % compression after 6 days

Temp Reg.	Week 12	Week 18	Week 20*	Week 24	Week 29	Week 37**	Mean
Blue print	11.3	8.0	7.7	6.3	6.2	6.6	7.68
Dutch	11.3	8.0	8.6	5.7	6.0	6.6	7.70
Combination	9.9	7.4	7.8	6.5	6.7	7.0	7.55
Blue print + low vent.	10.00	7.3	7.9	6.7	6.2	6.5	7.43
Mean	10.63	7.68	8.00	6.30	6.28	6.68	7.59

(*: after 7 days; **: after 5 days)

Efford EHS

Temperature regimes, F-Block Product life

Table 18 Firmness, % compression after 13 days

Temp Reg.	Week 12*	Week 18*	Week 20	Week 24	Week 29	Mean
Blue print	13.6	9.9	10.6	8.4	8.6	10.22
Dutch	15.4	10.7	11.7	8.5	8.7	11.00
Combination	12.4	9.6	10.6	8.4	9.4	10.08
Blue print + low vent.	13.2	10.4	10.4	8.9	8.8	10.34
Mean	13.65	10.15	10.83	8.55	8.88	10.41

(*: after 12 days)

Efford EHS

Temperature regimes F-Block Product life

Table 19 % uneatable, after 12 days

Temp Reg.	Week 18	Week 20*	Week 24	Week 29	Mean
Blue print	20	40	5	10	19
Dutch	50	70	10	15	36
Combination	60	45	11	10	32
Blue print + low vent.	37	40	16	20	28
Mean	42	49	11	14	29

(*: after 13 days)

Efford EHS

Temperature regimes F-Block Product life

Table 20 % fruit weight, after 6 days (weight at picking=100%)

Temp Reg.	Week 12	Week 18	Week 20*	Week 24	Week 29	Week 37	Mean
Blue print	95.8	94.5	96.3	96.4	97.4	97.1	96.25
Dutch	95.8	94.0	94.7	96.3	97.4	97.1	95.88
Combination	96.3	94.4	96.0	96.6	97.6	97.2	96.35
Blue print + low vent.	95.8	95.3	96.3	96.0	97.7	97.2	96.38
Mean	95.93	94.55	95.83	96.33	97.53	97.15	96.22

(*: after 5 days)

Efford EHS

Temperature regimes, F-Block Product life

Table 21 % fruit weight, after 12 days
(weight at picking = 100%)

Temp Reg.	Week 12	Week 18	Week 20*	Week 24	Week 29	Week 37**	Mean (excl. week 37)
Blue print	93.7	91.3	92.5	93.3	95.1	88.5	93.18
Dutch	93.4	89.4	90.9	92.7	94.9	88.5	92.26
Combination	93.8	90.5	91.9	93.7	95.4	89.5	93.06
Blue print + low vent.	92.5	90.6	92.8	92.7	95.0	88.9	92.72
Mean	93.35	90.45	92.03	93.10	95.10	88.05	92.81

(*: after 13 days; **:after 22 days)

Efford EHS

Temperature regimes, F-Block Composition

Table 22 % soluble solids (temperature corrected)

Temp reg.	Week 12	Week 18	Week 20	Week 24	Week 29	Week 37	Mean
Blue print	4.5	4.5	5.2	5.1	5.2	5.4	4.98
Dutch	4.8	5.0	5.8	4.9	5.1	5.3	5.15
Combination	4.7	4.2	5.1	5.0	5.1	5.2	4.88
Blue print + low vent.	4.5	5.2	5.0	4.9	5.3	5.2	5.02
Mean	4.63	4.73	5.28	4.98	5.18	5.28	5.01

Efford EHS

Temperature regimes, F-Block Composition

Table 23 Titratable acidity (mEq/100 ml sap)

Temp Reg.	Week 12	Week 18	Week 20	Week 24	Week 29	Week 37	Mean
Blue print	8.1	6.9	8.4	9.4	11.4	6.2	8.40
Dutch	7.6	7.6	8.4	11.4	10.8	5.6	8.57
Combination	8.4	6.0	8.4	9.4	11.4	5.5	8.18
Blue print + low vent.	6.9	8.1	7.8	8.4	10.8	5.6	7.93
Mean	7.75	7.15	8.25	9.65	11.10	5.75	8.27

Efford EHS

Temperature regimes, F-Block Physical appearance

Table 24 Boxiness, score (0-4)

Temp Reg.	Week 13	Week 16	Week 21	Week 25	Week 29	Week 33	Week 37	Mean
Blue print	.85	.02	.14	0	08	.08	.05	0.17
Dutch	1.13	.45	.28	0	.05	.10	.05	0.29
Combination	.83	.02	.09	.05	.03	.15	.03	0.17
Blue print + low vent.	1.09	.28	.29	.05	.15	.28	.20	0.33
Mean	.98	.19	0.20	0.03	0-08	.15	.08	0.24
Main treatments								
SED	.098	.168	.118	.057	.076	.176	.113	
LSD	-	-	-	-	-	-	-	
Signific.	ns	ns	ns	ns	ns	ns	ns	

Efford EHS

Temperature regimes, F-Block Physical appearance

Table 25 Ribbing, score (0-4)

Temp Reg.	Week 13	Week 16	Week 21	Week 25	Week 29	Week 33	Week 37	Mean
Blue print (control)	.52	.20	.39	.20	.10	.08	0.08	0.22
Dutch	.83	.80*	1.29	.33	.10	.03	.30	0.52
Combination	.45	.47	.79	.13	.15	.25	.30	0.36
Blue print + low vent.	.53	.38	.59	.20	.10	.08	.33	0.31
Mean	.58	.46	.76	.21	.11	0.11	.25	0.36
Main treatments								
SED	.095	.087	.212	.084	.035	.137	.126	
LSD	-	.276	-	-	-	-	-	
Signific.	ns	*	ns	ns	ns	ns	ns	
		(sig. at P=0.077)						

*sig. diff from control (Blueprint) at 5% level

Efford EHS

Temperature Regimes. F-Block Physical appearance

Table 26 Fine net cracking score (0-4)

Temp Reg.	Week 13	Week 16	Week 21	Week 25	Week 29	Week 33	Week 37	Mean
Blue print (control)	.13	.28	.22	.18	.03	.23	.80	0.26
Dutch	.22	1.18	1.75*	.40	.60	.53	.55	0.75
Combination	.31	.52	.42	.30	.30	.55	1.35	0.54
Blue print + low vent.	.05	.37	.40	.23	.05	.63	1.33	0.44
Mean	.18	.59	0.70	.28	.24	.48	1.01	0.50
Main treatments								
SED	.112	.395	.287	.421	.246	.400	.485	
LSD	-	-	.914	-	-	-	-	
Signific.	ns	ns	*	ns	ns	ns	ns	

*sig. diff from control (Blueprint) at 5% level

Efford EHS

Temperature regimes F-Block Physical appearance

Table 27 Radial cracking score (0-4)

Temp Reg.	Week 13	Week 16	Week 21	Week 25	Week 29	Week 33	Week 37	Mean
Blue print (control)	0	0	.25	.85	.43	.68	2.03	0.60
Dutch	0	.03	1.25*	.70	1.63	1.73	1.93	1.04
Combination	0	.02	.34	.85	1.08	1.25	2.60	0.88
Blue print + low vent.	0	0	.49	.53	.53	1.05	2.43	0.72
Mean	0	.01	.58	.73	.91	1.18	2.24	0.81
Main treatments								
SED			.196	.475	.521	0.350	.737	
LSD			*	ns	ns	ns	ns	
Signific.			0.625	-	-	-	-	

*sig. diff from control (Blueprint) at 5% level

Efford EHS

Temperature regimes, F-Block Physical appearance

Table 28 Uneven ripening score (0-4)

Temp Reg.	Week 13	Week 16	Week 21	Week 25	Week 29	Week 33	Week 37	Mean
Blue print (control)	0	0.12	.62	1.45	.80	.90	.90	0.68
Dutch	0	.10	.39	.78	.88	.63	.90	0.52
Combination	0	.10	.09	.60	.68	.78	1.20	0.49
Blue print + low vent.	.04	.12	.25	.68	.43	.95	1.025	0.50
Mean	.01	.11	.33	.88	.69	.81	1.00	0.55
Main treatments								
SED	.029	.014	.139	.263	.274	.419	.274	
LSD	-	-	-	-	-	-	-	
Signific.	ns	ns	ns	ns	ns	ns	ns	

Efford EHS

Temperature regimes, F-Block Physical appearance

Table 29 Gold spots score (0-4)

Temp Reg.	Week 13	Week 16	Week 21	Week 25	Week 29	Week 33	Week 37	Mean
Blue print (control)	.62	.07	.34	.55	1.15	1.63	2.43	0.97
Dutch	1.37	.40	1.55*	.68	.85	1.20	.63	0.95
Combination	1.06	.12	.64	.25	.88	1.60	.55	0.73
Blue print + low vent.	1.18	.15	.90	.45	.88	1.78	1.90	1.03
Mean	1.06	.19	.86	.48	.94	1.55	1.38	0.92
Main treatments								
SED	.168	.153	.213	.296	.306	.486	.654	
LSD	-	-	.679	-	-	-	-	
Signific.	ns	ns	*	ns	ns	ns	ns	

*sig. diff from control (Blueprint) ay 5% level

Efford EHS

Humidity & Nutrition trial M-Block Winter treatments Product life

Table 30 Firmness % compression, after 6 days

Treatment		Week 13	Week 15	
Main	Sub			
0.1	G	9.5	7.8	Where G = 5/150
	R	9.4	7.8	R = 5/300
	B	8.7	8.7	B = 7/150
	Y	10.3	7.9	Y = 7/300
0.2	G	8.8	7.7	
	R	10.1	7.5	
	B	9.1	7.2	
	Y	8.2	7.6	
0.4	G	8.6	7.5	
	R	9.8	7.4	
	B	8.7	7.9	
	Y	9.0	7.9	
0.8	G	8.4	7.0	
	R	8.8	7.3	
	B	8.7	8.0	
	Y	9.4	7.9	
Mean		9.09	7.69	
Mean	0.1	9.48	8.05	
	0.2	9.05	7.50	
	0.4	9.03	7.68	
	0.8	8.83	7.55	
Mean	G 5/150	8 83	7.50	
	R 5/300	9.53	7.50	
	B 7/150	8.80	7.95	
	Y 7/300	9.23	7.83	

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Product life

Table 31 Firmness % compression, after 13 days

Treatment		Week 13
Main	Sub	
0.1	G	13.5*
	R	13.1*
	B	12.7*
	Y	13.9*
0.2	G	13.0*
	R	12.1
	B	13.4*
	Y	12.2
0.4	G	12.4
	R	12.8
	B	11.6
	Y	12.7
0.8	G	11.1*
	R	10.6
	B	10.8
	Y	11.6*
Mean		12.34
Mean	0.1	13.30
	0.2	12.68
	0.4	12.38
	0.8	11.03
Mean	G 5/150	12.50
	R 5/300	12.15
	B 7/150	12.13
	Y 7/300	12.60

(* after 12 days)

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Product life

Table 32 % uneatable, after 12 days

Treatment		Week 13	Week 15
Main	Sub		
0.1	G	100	5
	R	94	10
	B	94	5
	Y	100	5
0.2	G	80	5
	R	80	15
	B	90	15
	Y	84	5
0.4	G	100	5
	R	95	5
	B	85	10
	Y	80	5
0.8	G	65	10
	R	65	10
	B	85	0
	Y	75	5
Mean		87.00	7.19
Mean	0.1	97.00	6.25
	0.2	83.50	10.00
	0.4	90.00	6.25
	0.8	77.50	6.25
Mean	G 5/150	86.25	6.25
	R 5/300	88.50	10.00
	B 7/150	88.50	7.50
	Y 7/300	84.75	5.00

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Product life

Table 33 % fruit weight, after 6 days (1 day = 100%)

Treatment		Week 13*	Week 15	
Main	Sub			
0.1	G	92.7	94.5	Where G = 5/150
	R	93.9	94.6	R = 5/300
	B	93.8	94.5	B = 7/150
	Y	92.7	94.5	Y = 7/300
0.2	G	94.3	94.7	
	R	93.9	94.6	
	B	94.4	95.0	
	Y	94.3	96.1	
0.4	G	94.4	94.5	
	R	94.4	94.1	
	B	94.7	95.0	
	Y	94.5	95.0	
0.8	G	94.7	95.0	
	R	95.1	94.8	
	B	95.2	94.9	
	Y	94.8	94.8	
Mean		94.24	94.79	
Mean	0.1	93.28	94.53	
	0.2	94.23	95.10	
	0.4	94.50	94.65	
	0.8	94.95	94.88	
Mean	G 5/150	94.03	94.68	
	R 5/300	94.33	94.53	
	B 7/150	94.53	94.85	
	Y 7/300	94.08	95.10	

* after 5 days

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Product life

Table 34 % fruit weight, after 12 days (1 day = 100%)

Treatment		Week 13*	Week 15**
Main	Sub		
0.1	G	86.6	92.0
	R	89.1	92.0
	B	89.3	91.7
	Y	87.1	92.0
0.2	G	90.4	92.5
	R	89.4	91.7
	B	89.2	92.4
	Y	89.3	94.3
0.4	G	87.7	92.1
	R	89.2	91.6
	B	90.0	93.4
	Y	90.0	93.3
0.8	G	91.1	93.1
	R	91.3	92.2
	B	90.4	93.3
	Y	90.8	92.6
Mean		89.43	92.51
Mean	0.1	88.03	91.93
	0.2	89.58	92.73
	0.4	89.23	92.60
	0.8	90.90	92.80
Mean	G 5/150	88.95	92.43
	R 5/300	89.75	91.88
	B 7/150	89.73	92.78
	Y 7/300	89.30	93.05

Where G = 5/150
R = 5/300
B = 7/150
Y = 7/300

(*: after 11 days)

(**: after 9 days)

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Composition

Table 35 % soluble solids (temperature corrected)

Treatment		Week 13	Week 15
Main	Sub		
0.1	G	4.4	3.7
	R	4.5	3.5
	B	4.7	4.3
	Y	4.7	4.8
0.2	G	4.4	4.8
	R	4.4	4.5
	B	4.6	5.4
	Y	4.6	5.0
0.4	G	4.1	4.1
	R	4.2	4.1
	B	4.6	4.6
	Y	4.4	4.2
0.8	G	4.3	4.1
	R	4.2	4.1
	B	4.3	4.4
	Y	4.3	4.5
Mean		4.42	4.38
Mean	0.1	4.58	4.08
	0.2	4.50	4.93
	0.4	4.33	4.25
	0.8	4.28	4.28
Mean	G 5/150	4.30	4.18
	R 5/300	4.33	4.05
	B 7/150	4.55	4.68
	Y 7/300	4.50	4.63

Efford EHS

Humidity & Nutrition trial M-Block Winter treatments Composition

Table 36 Titratable acidity (mEq/100 ml sap)

Treatment		Week 13	Week 15
Main	Sub		
0.1	G	6.4	5.3
	R	8.7	4.9
	B	8.4	6.9
	Y	-	8.7
0.2	G	5.3	8.4
	R	7.4	7.8
	B	5.3	9.4
	Y	8.7	8.4
0.4	G	4.6	6.9
	R	5.5	6.0
	B	4.1	7.8
	Y	4.5	7.4
0.8	G	3.7	6.9
	R	3.4	6.5
	B	4.9	7.8
	Y	8.1	7.8
Mean		5.93	7.31
Mean	0.1	7.83	6.45
	0.2	6.68	8.50
	0.4	4.68	7.03
	0.8	5.03	7.25
Mean	G 5/150	5.00	6.88
	R 5/300	6.25	6.30
	B 7/150	5.68	7.98
	Y 7/300	7.10	8.08

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Physical appearance

Table 37 Boxiness score (0-4)

Treatments Main	Sub	Week 12	Week 14	Week 18	Week 25	Week 26
0.1	5/150	1.50	.55	1.00		.15
	5/300	1.85	.90	.80		.45
	7/150	2.25	.10	.50		.20
	7/300	.85	.20	.10		.30
	Mean	1.61	.44	.60		.28
0.2	5/150	1.00	.35	.80	.03	.20
	5/300	1.00	.55	.10		.30
	7/150	.85	.10	.35	.13	0
	7/300	.90	.35	.50		.45
	Mean	.94	.34	.44	.08	.24
0.4	5/150	1.60	.30	.85		.30
	5/300	1.60	.45	.85		.10
	7/150	1.50	.25	.75		.20
	7/300	.90	.25	.45		.10
	Mean	1.40	.31	.73		.18
0.8	5/150	1.25	.25	.90		.10
	5/300	1.45	.85	.40		.50
	7/150	1.40	.20	.90		.20
	7/300	1.71	.40	.70		.10
	Mean	1.45	.43	.73		.23
Mean	0.1	1.61	.44	.60		.28
	0.2	.94	.34	.44	.08	.24
	0.4	1.40	.31	.73		.18
	0.8	1.45	.43	.73		.23
Mean	5/150(c)	1.34	.36	.89	.03	.19
	5/300	1.48	.69	.54		.34
	7/150	1.50	.16	.63	.13	.15
	7/300	1.09	.30	.44		.24
Grand mean		1.35	.38	.62	.08	.23
Main	SED		.193			.064
	LSD		-			-
	Signific.		ns			ns
Sub	SED		.114			.108
	LSD		*: .3620			-
			**: .6645			
	Signific.		**			ns

* sig. diff from control at 5% level

** " " " " " 1% "

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Physical appearance

Table 38 Fine net cracking score (0-4)

Treatments Main	Sub	Week 12	Week 14	Week 18	Week 25	Week 26
0.1	5/150	.00	.85	.50		.10
	5/300	.00	.40	.30		.05
	7/150	.00	.90	.80		.15
	7/300	.00	.90	1.30		.05
	Mean	.00	.76	.73		.09
0.2	5/150	.15	1.00	.60	.23	.10
	5/300	.05	1.40	.60		.05
	7/150	.00	.30	.85	.47	.15
	7/300	.15	.65	.80		.10
	Mean	.09	.84	.71	.35	.10
0.4	5/150	.05	.80	.55		.10
	5/300	.10	1.15	.95		.25
	7/150	.00	.60	.40		.10
	7/300	.05	.40	.75		.05
	Mean	.05	.74	.66		.13
0.8	5/150	.00	1.60	1.10		.05
	5/300	.00	1.45	.60		.05
	7/150	.00	1.70	.20		.20
	7/300	.00	1.15	.40		.20
	Mean	.00	1.48	.58		.13
Mean	0.1	.00	.76	.73		.09
	0.2	.09	.84	.71	.35	.10
	0.4	.05	.74	.66		.13
	0.8	.00	1.48	.58		.13
Mean	5/150(c)	.05	1.06	.69	.23	.09
	5/300	.04	1.10	.61		.10
	7/150	.00	.88	.56	.47	.15
	7/300	.05	.78	.81		.10
Grand mean		.03	.95	.67	.35	.11
Mean	SED		.419			.044
	LSD		-			-
	Signific.		ns			ns
Sub	SED		.094			.068
	LSD		* .300			-
	Signific.		*			ns

*sig. diff between control (Nutrient regime 5/150) at 5% level

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Physical appearance

Table 39 Radial cracking score (0-4)

Treatments Main	Sub	Week 12	Week 14	Week 18	Week 25	Week 26
0.1	5/150	.00	.00	.70		1.00
	5/300	.00	.00	.40		.55
	7/150	.00	.00	.60		.70
	7/300	.00	.00	.50		.75
	Mean	.00	.00	.55		.75
0.2	5/150	.00	.00	.30	.83	.85
	5/300	.00	.00	.15		.70
	7/150	.00	.00	.35	.57	.45
	7/300	.00	.00	.20		.50
	Mean	.00	.00	.25	.70	.63
0.4	5/150	.00	.00	.25		1.05
	5/300	.00	.00	.55		.95
	7/150	.00	.00	.10		.45
	7/300	.00	.00	.25		.75
	Mean	.00	.00	.29		.80
0.8	5/150	.00	.00	.50		.75
	5/300	.00	.00	.00		.90
	7/150	.00	.00	.00		.75
	7/300	.00	.00	.00		.95
	Mean	.00	.00	.13		.84
Mean	0.1	.00	.00	.55		.75
	0.2	.00	.00	.25	.70	.63
	0.4	.00	.00	.29		.88
	0.8	.00	.00	.13		.84
Mean	5/150	.00	.00	.44	.83	.91
	5/300	.00	.00	.28		.78
	7/150	.00	.00	.26	.57	.59
	7/300	.00	.00	.24		.74
Grand mean		.00	.00	.30	.70	.75
Main	SED					.119
	LSD					-
	Signific					ns
Sub	SED					.157
	LSD					-
	Signific					ns

Efford EHS

Humidity & Nutrition trial, M-Block Winter treatments Physical appearance

Table 40 Gold spots score (0-4)

Treatments Main	Sub	Week 12	Week 14	Week 18	Week 25	Week 26
0.1	5/150	1.60	1.75	.50		1.40
	5/300	1.90	2.45	1.10		1.70
	7/150	1.25	1.75	1.20		.65
	7/300	2.15	2.55	.60		.65
	Mean	1.73	2.13	.85		1.10
0.2	5/150	1.60	.75	.90	.57	.95
	5/300	2.30	1.75	.45		.75
	7/150	1.00	1.05	.75	.37	.70
	7/300	2.00	2.10	.95		1.15
	Mean	1.73	1.41	.76	.47	.89
0.4	5/150	1.70	.55	.10		1.55
	5/300	2.05	1.15	.25		1.80
	7/150	1.25	.85	1.15		.85
	7/300	2.50	2.25	.60		.85
	Mean	1.88	1.20	.53		1.26
0.8	5/150	.85	.70	.00		1.05
	5/300	1.35	1.75	.10		1.30
	7/150	1.20	1.10	1.30		.65
	7/300	1.38	2.15	.50		1.60
	Mean	1.20	1.43	.48		1.15
Mean	0.1	1.73	2.13	.85		1.10
	0.2	1.73	1.41	.76	.47	.89
	0.4	1 88	1.20	.53		1.26
	0.8	1.20	1.43	.48		1.15
Mean	5/150(c)	1.44	.94	.38	.57	1.24(c)
	5/300	1.90	1.78*	.48		1.39
	7/150	1.18	1.19	1.10	.37	.71*
	7/300	2.01	2.26**	.66		1.06
Grand mean		1.63	1.54	.65	.47	1.10
Main	SED		.3167			.3647
	LSD		-			-
	Signific.		ns			ns
Sub	SED		.171			.142
	LSD		* .544			*: .453
			**: 0.999			**: .831
			***: 2.21			
	Signific.		***			**

* sig. diff from control (Nutrient regime 5/150) at 5% level

** " " " " " " " 1% "

*** " " " " " " " 0.1% "

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Product life

Table 41 Firmness % compression, after 6 days

Treatment		Week 28	Week 32	Week 36	Mean
LL	2.5	8.1	6.9	7.4	7.47
	3.5	7.5	7.2	7.1	7.27
	4.5	7.7	7.0	7.1	7.27
	5.5	7.5	7.2	7.4	7.37
LH	2.5	8.3	6.7	7.3	7.43
	3.5	7.5	6.9	7.5	7.30
	4.5	7.5	6.8	7.2	7.17
	5.5	8.2	6.9	7.7	7.60
HL	2.5	7.5	6.8	7.3	7.20
	3.5	7.6	6.9	7.3	7.27
	4.5	8.0	6.8	7.5	7.43
	5.5	7.9	7.0	7.5	7.47
HH	2.5	8.3	7.1	7.4	7.60
	3.5	7.8	6.9	7.5	7.40
	4.5	7.7	7.0	7.5	7.40
	5.5	8.1	7.1	7.5	7.57
Mean		7.83	6.95	7.39	7.39
Mean	LL	7.70	7.08	7.25	7.34
	LH	7.88	6.83	7.43	7.38
	HL	7.75	6.88	7.40	7.34
	HH	7.98	7.03	7.48	7.49
Mean	2.5	8.05	6.88	7.35	7.43
	3.5	7.60	6.98	7.35	7.31
	4.5	7.73	6.90	7.33	7.32
	5.5	7.93	7.05	7.53	7.50

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Product life

Table 42 Firmness, % compression, after 13 days

Treatment		Week 28	Week 32	Week 36	Mean
LL	2.5	9.5	9.7	9.6	9.60
	3.5	9.4	9.3	9.4	9.37
	4.5	9.6	9.6	9.4	9.53
	5.5	9.5	9.8	9.4	9.57
LH	2.5	10.1	9.9	10.4	10.13
	3.5	10.5	9.8	9.7	10.00
	4.5	9.9	9.8	10.2	9.97
	5.5	9.7	10.1	10.5	10.10
HL	2.5	10.0	9.2	9.9	9.70
	3.5	10.1	9.2	10.6	9.97
	4.5	9.7	9.0	9.8	9.50
	5.5	9.4	9.4	9.7	9.50
HH	2.5	9.8	10.5	9.9	10.07
	3.5	9.0	10.2	10.5	9.98
	4.5	9.6	9.5	10.0	9.70
	5.5	9.8	10.2	9.6	9.87
Mean		9.73	9.70	9.91	9.78
Mean	LL	9.50	9.60	9.45	9.52
	LH	10.05	9.90	10.20	10.05
	HL	9.80	9 20	10.00	9.67
	HH	9.55	10.10	10.00	9.88
Mean	2.5	9.85	9.83	9.95	9.88
	3.5	9.75	9.63	10.05	9.81
	4.5	9.70	9.48	9.85	9.68
	5.5	9.60	9.88	9.80	9.76

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Product life

Table 43 % uneatable, after 12 days

Treatment		Week 28	Week 32	Week 36*	Week 40	Mean
LL	2.5	65	20	37	53	43.70
	3.5	65	10	5	33	28.33
	4.5	70	10	20	71	42.65
	5.5	80	15	12	41	36.99
LH	2.5	75	25	42	47	47.37
	3.5	85	15	32	60	47.89
	4.5	75	20	30	86	52.68
	5.5	80	20	15	89	51.07
HL	2.5	85	15	46	47	48.30
	3.5	75	0	35	63	43.20
	4.5	85	5	20	39	37.22
	5.5	70	5	6	45	31.68
HH	2.5	100	35	30	60	56.25
	3.5	100	35	16	61	52.98
	4.5	95	15	37	69	53.90
	5.5	100	35	24	40	49.63
Mean		81.56	17.50	25.41	56.49	45.24
Mean	LL	70.00	13.75	18.40	49.51	37.92
	LH	78.75	20.00	29.77	70.49	49.75
	HL	78.75	6.25	26.92	48.48	40.10
	HH	98.75	30.00	26.54	57.47	53.19
Mean	2.5	81.25	23.75	38.78	51.84	48.90
	3.5	81.25	15.00	21.92	54.24	43.10
	4.5	81.25	12.50	26.71	65.99	46.61
	5.5	82.50	18.75	14.23	53.88	42.34

(*: after 13 days)

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Product life

Table 44 % fruit weight, after 6 days (1 day = 100%)

Treatment		Week 28	Week 32	Week 36*	Week 40	Mean
LL	2.5	95.0	96.6	97.9	96.2	96.43
	3.5	95.3	96.8	98.1	96.1	96.58
	4.5	95.3	96.8	98.1	95.8	96.50
	5.5	95.3	96.2	98.1	96.0	96.48
LH	2.5	96.0	96.7	98.0	96.0	96.68
	3.5	96.2	96.8	98.0	96.2	96.80
	4.5	96.4	96.8	98.0	95.7	96.73
	5.5	96.2	96.9	97.9	95.3	96.58
HL	2.5	95.9	96.7	97.4	96.2	96.55
	3.5	96.2	96.7	97.8	96.1	96.70
	4.5	96.3	96.9	97.7	96.2	96.78
	5.5	94.9	96.9	97.8	95.9	96.38
HH	2.5	94.1	96.2	98.0	95.8	96.03
	3.5	94.9	96.6	97.8	95.5	96.20
	4.5	94.7	96.3	97.8	95.5	96.08
	5.5	94.7	96.1	97.5	95.5	95.95
Mean		95.46	96.63	97.87	95.88	96.46
Mean	LL	95.23	96.60	98.05	96.03	96.48
	LH	96.20	96.80	97.98	95.80	96.69
	HL	95.83	96.80	97.68	96.10	96.60
	HH	94.60	96.30	97.78	95.58	96.06
Mean	2.5	95.25	96.55	97.83	96.05	96.42
	3.5	95.65	96.73	97.93	95.98	96.57
	4.5	96.68	96.70	97.90	95.80	96.52
	5.5	95.28	96.53	97.83	95.68	96.33

(*: after 5 days)

Efford EHS

Humidity & Nutr tion trial, M-Block Summer treatment Product life

Table 45 % fruit weight, after 12 days (1 day=100%)

Treatment		Week 28	Week 32	Week 36	Week 40*	Mean
LL	2.5	92.4	94.2	95.2	91.5	93.33
	3.5	92.6	93.6	95.8	92.0	93.50
	4.5	92.3	93.9	95.8	90.8	93.20
	5.5	92.1	93.4	95.7	91.7	93.23
LH	2.5	92.6	94.0	95.5	90.5	93.15
	3.5	92.6	93.5	95.4	91.7	93.30
	4.5	93.4	93.5	95.6	91.2	93.43
	5.5	93.3	93.7	95.2	89.6	92.95
HL	2.5	92.3	94.2	95.3	91.4	93.30
	3.5	92.6	94.2	95.4	91.0	93.30
	4.5	93.2	94.7	95.4	92.2	93.88
	5.5	92.5	94.8	95.4	91.1	93.45
HH	2.5	90.6	93.3	96.0	91.0	92.73
	3.5	91.4	93.5	95.3	91.0	92.80
	4.5	91.5	93.4	95.4	90.3	92.65
	5.5	91.6	92.7	95.4	90.9	92.65
Mean		92.31	93.79	95.49	91.12	93.18
Mean	LL	92.35	93.78	95.63	91.50	93.31
	LH	92.98	93.68	95.43	90.75	93.21
	HL	92.65	94.48	95.38	91.43	93.48
	HH	91.28	93.23	95.53	90.90	92.71
Mean	2.5	91.98	93.93	95.50	91.10	93.13
	3.5	92.30	93.70	95.48	91.43	93.23
	4.5	92.60	93.88	95.55	91.13	93.29
	5.5	92.38	93.65	95.43	90.83	93.07

(*: after 13 days)

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Composition

Table 46 % soluble solids (temperature corrected)

Treatment		Week 28	Week 32	Week 36	Week 40	Mean
LL	2.5	5.3	4.8	4.8	4.7	4.90
	3.5	5.4	4.9	4.9	4.9	5.03
	4.5	5.2	4.9	5.1	5.1	5.08
	5.5	5.4	5.1	5.2	5.5	5.30
LH	2.5	5.0	5.4	4.6	4.5	4.88
	3.5	5.0	5.2	4.8	4.9	4.98
	4.5	5.3	4.9	5.0	5.1	5.08
	5.5	5.7	5.3	5.0	5.3	5.33
HL	2.5	5.3	4.7	4.8	4.9	4.93
	3.5	4.4	5.1	4.8	5.0	5.10
	4.5	5.5	5.0	4.8	5.1	5.10
	5.5	5.8	5.2	5.0	5.5	5.38
HH	2.5	5.5	4.7	4.8	4.5	4.88
	3.5	5.2	5.4	5.2	4.9	5.18
	4.5	5.3	5.0	5.2	5.0	5.13
	5.5	5 5	5.1	5.2	5.4	5.30
Mean		5.37	5.04	4.95	5.02	5.10
Mean	LL	5.33	4.93	5.00	5.05	5.08
	LH	5.25	5.20	4.85	4.95	5.06
	HL	5.53	5.00	4.85	5.13	5.13
	HH	5.38	5.05	5.10	4.95	5.12
Mean	2.5	5.28	4.90	4.75	4.65	4.89
	3.5	5.28	5.15	4.93	4.93	5.07
	4.5	5.33	4.95	5.03	5.08	5.09
	5.5	5.60	5.18	5.10	5.43	5.33

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Composition

Table 47 Acidity (mEq/100 ml sap)

Treatment		Week 28	Week 32	Week 36	Week 40	Mean
LL	2.5	8.4	5.4	4.8	5.3	5.98
	3.5	7.1	5.9	5.3	6.4	6.18
	4.5	6.4	7.8	5.9	6.7	6.70
	5.5	6.7	6.4	6.0	7.4	6.63
LH	2.5	5.4	6.0	4.8	4.7	5.25
	3.5	5.8	6.9	5.1	5.6	5.85
	4.5	6.4	6.9	5.8	7.1	6.55
	5.5	6.7	7.4	6.4	7 4	6.98
HL	2.5	6.4	5.3	5.3	5.4	5.60
	3.5	6.2	6.5	5.2	6.2	6.03
	4.5	6.7	6.0	5.6	5.9	6.05
	5.5	7.6	7.1	6.4	8.1	7.30
HH	2.5	7.1	5.0	4.6	5.2	5.48
	3.5	6.4	6.9	5.1	6.0	6.10
	4.5	6.4	6.2	5.6	6.7	6.23
	5.5	6.7	7.4	5.8	7.6	6.88
Mean		6.65	6.44	5.48	6.36	6.23
Mean	LL	7.15	6.38	5.50	6.45	6.37
	LH	6.08	6.80	5.53	6.23	6.16
	HL	6.73	6.23	5.63	6.40	6.25
	HH	6.65	6.38	5.28	6.38	6.17
Mean	2.5	6.83	5.43	4.88	5.18	5.58
	3.5	6.38	6.55	5.18	6.05	6.04
	4.5	6.48	6.73	5.73	6.60	6.39
	5.5	6.93	7.08	6.15	7.63	6.95

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Physical appearance

Table 48 Boxiness score (0-4)

Treatment		Week 26	Week 30	Week 34	Week 40
LL	2.50	.20	.10	.30	1.30
	3.50	.30	.20	.20	.40
	4.50	.05	.15	.05	.20
	5.50	.45	.35	.00	.70
	Mean	.25	.20	.14	.65
LH	2.50	.45	.55	.20	.85
	3.50	.30	.10	.15	.55
	4.50	.15	.65	.35	.35
	5.50	.20	.25	.00	.15
	Mean	.28	.39	.18	.48
HL	2.50	.05	.00	.10	.55
	3.50	.30	.10	.00	1.10
	4.50	.10	.25	.10	.75
	5.50	.20	.25	.00	.30
	Mean	.16	.15	.05	.68
HH	2.50	.10	.00	.45	.75
	3.50	.45	.10	.05	1.00
	4.50	.25	.30	.10	.65
	5.50	.10	.15	.15	.30
	Mean	.23	.14	.19	.68
Grand mean		.23	.22	.14	.62
Mean	LL	.25	.20	.14	.65
	LH	.28	.39	.18	.48
	HL	.16	.15	.05	.68
	HH	.23	.14	.19	.68
Main	SED	.053	.121	.087	.249
	LSD	-	-	-	-
	Sign.	ns	ns	ns	ns
Mean	2.5(c)	.20	.16	.26	.86
	3.5	.34	.13	.10	.76
	4.5	.14	.34	.15	.49
	5.5	.24	.25	.04*	.36
Sub	SED	.115	.125	.066	.207
	LSD	-	-	.209	-
	Sign.	ns	ns	*	ns

*sig. diff from control at 5% level

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Physical appearance

Table 50 Nippling score (0-4)

Treatment		Week 26	Week 30	Week 34	Week 40
LL	2.50	.15	.30	.50	.15
	3.50	.15	.25	.75	.45
	4.50	.55	.30	.80	.20
	5.50	.20	.30	.70	.10
	Mean	.26	.29	.69	.23
LH	2.50	.35	.30	.85	.25
	3.50	.05	.35	.70	.70
	4.50	.40	.35	.75	.40
	5.50	.20	.35	.85	.45
	Mean	.25	.34	.79	.45
HL	2.50	.10	.45	.40	.15
	3.50	.55	.25	.70	.25
	4.50	.10	.40	.80	.25
	5.50	.25	.45	.80	.25
	Mean	.25	.39	.68	.23
HH	2.50	.20	.40	.45	.40
	3.50	.35	.40	.35	.40
	4.50	.40	.50	.75	.25
	5.50	.35	.60	.60	.35
	Mean	.33	.48	.54	.35
	Mean	.27	.37	.67	.31
Mean	LL	.26	.29	.69	.23
	LH	.25	.34	.79	.45
	HL	.25	.39	.68	.23
	HH	.33	.48	.54*	.35
Main	SED	.088	.094	.044	.148
	LSD	-	-	*.141	-
	Sign.	ns	ns	*	ns
Mean	2.5(c)	.20	.36	.55	.24
	3,5	.28	.31	.63	.45
	4.5	.36	.39	.78	.28
	5.5	.25	.43	.74	.29
Sub	SED	.131	.094	.107	.078
	LSD	-	-	-	-
	Sign.	ns	ns	ns	ns

*sig. diff from control at 5% level

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Physical appearance

Table 51 Fine net cracking score (0-4)

Treatment		Week 26	Week 30	Week 34	Week 40
LL	2.50	.10	.55	.40	1.55
	3.50	.05	.60	.50	1.10
	4.50	.10	.20	.35	1.85
	5.50	.05	.10	.70	1.20
	Mean	.08	.36	.49	1.43
LH	2.50	.00	1.25	.25	1.40
	3.50	.10	.90	.60	1.80
	4.50	.15	.70	1.00	1.15
	5.50	.20	.55	.90	1.65
	Mean	.11	.85	.69	1.50
HL	2.50	.30	.85	1.20	1.25
	3.50	.15	.15	1.10	1.30
	4.50	.05	.80	.20	.85
	5.50	.10	.10	.50	1.10
	Mean	.15	.48	.75	1.13
HH	2.50	.15	.50	1.40	1.10
	3.50	.05	.95	.75	1.10
	4.50	.20	.45	.55	1.55
	5.50	.00	.40	.95	1.15
	Mean	.10	.58	.91	1.23
	Mean	.11	.57	.71	1.32
Mean	LL	.08	.36	.49	1.43
	LH	.11	.85	.69	1.50
	HL	.15	.48	.75	1.13
	HH	.10	.58	.91	1.23
Main	SED	.027	.200	.108	.266
	LSD	-	-	-	-
	Sign.	ns	ns	ns	ns
Mean	2.5	.14	.79	.81	1.33
	3.5	.09	.65	.74	1.33
	4.5	.13	.54	.53	1.35
	5.5	.09	.29	.76	1.28
Sub	SED	.058	.220	.152	.276
	LSD	-	-	-	-
	Sign.	ns	ns	ns	ns

Efford EHS

Humidity & Nutrition trial M-block Summer treatment Physical appearance

Table 52 Radial cracking score (0-4)

Treatment		Week 26	Week 30	Week 34	Week 40
LL	2.50	1.10	1.60	.85	1.90
	3.50	.65	1.40	1.90	2.10
	4.50	.80	1.10	1.65	2.95
	5.50	.55	1.30	1.50	2.80
	Mean	.78	1.35	1.48	2.44
LH	2.50	.65	2.55	1.15	1.80
	3.50	.70	1.65	1.50	2.40
	4.50	.80	1.30	1 80	2 55
	5.50	.70	1.95	1.30	3.05
	Mean	.71	1 86	1·44	2.45
HL	2.50	.60	1.60	1.90	1.55
	3.50	1.00	1.55	2.15	2.55
	4.50	.50	2.60	1.25	2.05
	5.50	.50	.90	1.30	2.60
	Mean	.76	1.66	1.65	2.19
HH	2.50	1.15	1.45	2.10	2.05
	3.50	.60	2.20	1.60	2.45
	4.50	.95	1.55	1.55	3.00
	5.50	.80	1.50	1.70	2.80
	Mean	.88	1.68	1.74	2.58
	Mean	.75	1.64	1.58	2.41
Mean	LL(c)	.78	1.35	1.48	2.44
	LH	.71	1.86	1.44	2.45
	HL	.65	1.66	1.65	2.19
	HH	.88	1.68	1.74	2.58
Main	SED	.1131	.189	.157	.260
	LSD	-	-	-	-
	Sign.	ns	ns	ns	ns
Mean	2.5(c)	.88	1.80	1.50	1.83
	3.5	.74	1.70	1.79	2.38
	4.5	.76	1.64	1.56	2.64*
	5.5	.64	1.41	1.45	2.81*
Sub	SED	.149	.368	.187	.218
	LSD	-	-	-	*: .695 **:1.275
	Sign.	ns	ns	ns	**

* sig. diff from control at 5% level

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatment Physical appearance

Table 53 Uneven ripening score (0-4)

Treatment		Week 26	Week 30	Week 34	Week 40
LL	2.50	.55	1.25	1.35	1.50
	3.50	.60	1.25	1.05	1.25
	4.50	.60	1.30	.90	.70
	5.50	.55	.90	.90	.45
	Mean	.58	1.18	1.05	.98
LH	2.50	.80	1.70	.95	1.35
	3.50	1.00	.80	1.10	1.00
	4.50	.40	.80	.45	.55
	5.50	.45	.95	.50	.50
	Mean	.66	1.06	.75	.85
HL	2.50	1.00	1.55	1.90	2.10
	3.50	.65	1.20	1.35	.95
	4.50	.60	1.05	.85	.90
	5.50	.65	.55	1.15	.35
	Mean	.73	1.09	1.31	1.08
HH	2.50	.60	.95	1.25	1.00
	3.50	.45	1.35	.95	1.05
	4.50	.50	1.20	.95	.70
	5.50	.50	.65	.60	.35
	Mean	.51	1.04	.94	.78
	Mean	.62	1.09	1.01	.92
Mean	LL(c)	.58	1.18	1.05	.98
	LH	.66	1.06	75	.85
	HL	.73	1.09	1.31	1.08
	HH	.51	1.04	.94	.78
Main	SED	.088	.049	.230	.164
	LSD	-	-	-	-
	Sign.	ns	ns	ns	ns
Mean	2.5(c)	1.36	.74	1.36	1.49(c)
	3.5	.68	1.15	1.11	1.06
	4.5	.53	1.09	.79*	.71*
	5.5	.54	.76	.79*	.41**
Sub	SED	.115	.220	.125	.162
	LSD	-	-	*:.398 **: 731	*:.516 **:.948 ***:2.098
	Sign.	ns	ns	**	***

*sig. diff from control at 5% level **sig. diff from control at 1% level

Efford EHS

Humidity & Nutrition trial, M-Block Summer treatments Physical appearance

Table 54 Gold spots score (0-4)

Treatment		Week 26	Week 30	Week 34	Week 40
LL	2.50	.75	1.10	1.75	1.70
	3.50	.60	1.15	1.00	1.20
	4.50	.95	1.20	.55	.35
	5.50	1.15	1.70	.25	.25
	Mean	.86	1.29	.89	.88
LH	2.50	.90	.80	1.75	1.05
	3.50	1.15	1.10	1.30	1.00
	4.50	1.75	2.25	1.00	.30
	5.50	1.55	.80	.25	.20
	Mean	1.34	1.24	1.08	.64
HL	2.50	1.55	1.40	2.30	1.45
	3.50	1.55	.75	1.55	1.00
	4.50	1.05	1.05	.80	1.00
	5.50	1.00	1.40	.45	.15
	Mean	1.29	1.15	1.28	.90
HH	2.50	1.25	1.85	1.50	1.85
	3.50	.80	1.00	1.50	1.10
	4.50	1.05	1.65	.85	.75
	5.50	.55	1.25	.35	.25
	Mean	.91	1.44	1.05	.99
	Mean	1.10	1.28	1.07	.85
Mean	LL	.86	1.29	.89	.88
	LH	1.34	1.24	1.08	.64
	HL	1.29	1.15	1.28	.90
	HH	.91	1.44	1.05	.99
Main	SED	.246	.165	.222	.105
	LSD	-	-	-	-
	Sign.	ns	ns	ns	ns
Mean	2.5(c)	1.11	1.29	1.83	1.51
	3.5	1.03	1.00	1.34	1.08
	4.5	1.20	1.54	.80*	.60*
	5.5	1.06	1.29	.33**	.21**
Sub	SED	.250	.251	.239	.2075
	LSD	-	-	*.76	* .660
				**:1.398	**1.212
				***:3.093	***2.682
	Sign.	ns	ns	***	***

*sig. diff from control at 5% level **sig. diff from control at 1% level

Luddington EHS

Variety trial Product life

Table 56 Weight loss during shelf life. (Percentage of original weight after 6 days)

Variety	Week 34	37	39	Mean
Counter	95.5	95.6	91.4	94.2
Criterium	93.7	93.4	90.2	92.4
Turbo	95.4	94.6	94.2	94.7
662	93.4	93.5	92.1	93.0
663	93.1	95.0	92.4	93.5
W690	95.2	94.8	93.7	94.6
W1007	94.6	94.4	92.1	93.7
2015	94.6	94.7	91.3	93.5
Goldstar	93.7	94.1	92.9	93.6
RS85042	94.3	93.9	93.9	94.0
Shirley	96.6	95.8	94.8	95.7
RS84065	93.5	94.0	88.2	91.9
Dario	96.7	95.6	94.2	95.5
Novy	96.9	-	-	-
B366	94.5	-	-	-
Mean	94.8	94.6	92.4	93.9

Luddington EHS

Variety trial Product life

Table 55 Firmness analysis - mm depression (6 days)

Variety	Wk 32 4/8/87	34 18/8/87	37 7/9/87	Mean
Counter	3.27	3.04	3.68	3.33
Criterium	3.20	2.95	3.23	3.13
Turbo	3.25	2.98	3.53	3.25
662	3.34	3.29	3.58	3.40
663	4.04	3.31	3.53	3.63
W690	3.87	3.32	3.64	3.61
W1007	3.58	3.77	3.92	3.75
2015	3.13	3.10	3.45	3.23
Goldstar	2.81	3.12	3.49	3.14
RS85042	3.37	3.09	3.35	3.27
Shirley	3.81	3.22	4.11	3.71
RS84065	3.25	3.26	3.45	3.32
Dario	3.34	3.52	3.47	3.44
Novy	2.88	3.03	2.67	2.86
B366	2.53	2.86	3.56	2.98
Mean	3.32	3.19	3.51	3.34
SED	0.151	0.258	0.529	
LSD (p=0.05)	*0.309			
	**0.450			
	***0.625			
Sig.	***	NS	NS	

***sig. diff between varieties at 0.1% level

Luddington EHS

Variety trial Product life

Table 57 % soluble solids

Variety	Wk 32 date 4/8	34 18/8/87	37 7/9/87	39 21/9/87	Mean
Counter	4.0	4.4	4.6	5.0	4.5
Criterium	4.0	4.2	4.6	5.2	4.5
Turbo	4.0	4.6	4.5	5.1	4.6
662	4.1	4.8	5.0	5.4	4.8
663	4.3	4.7	4.6	5.8	4.9
W690	4.1	4.2	4.9	5.0	4.6
W1007	4.2	4.5	4.4	4.8	4.5
2015	4.1	4.7	4.7	4.8	4.6
Goldstar	3.7	4.3	4.6	4.9	4.4
RS85042	3.9	4.7	4.6	5.3	4.6
Shirley	3.9	4.5	4.8	5.1	4.6
RS84065	3.8	4.6	4.8	5.4	4.7
Dario	3.9	4.3	4.3	4.6	4.3
Novy	4.6	4.9	5.3	5.3	5.0
B366	4.9	4.6	5.2	5.8	5.1
Mean	4.1	4.5	4.7	5.2	

Luddington EHS

Variety trial Product life

Table 58 Acidity (mEq/100 ml sap)

Variety	Wk 32 date 4/8	34 18/8/87	37 7/9/87	39 21/9/87	Mean
Counter	4.6	8.4	10.3	9.4	8.18
Criterium	4.7	7.8	8.4	9.4	7.58
Turbo	5.0	7.4	9.8	10.8	8.25
662	4.9	8.4	10.3	11.4	8.75
663	5.0	8.4	9.4	10.8	8.40
W690	5.0	7.6	9.8	9.8	8.05
W1007	4.9	9.0	9.4	10.8	8.53
2015	4.8	7.8	9.8	9.0	7.85
Goldstar	4.9	9.0	9.4	9.0	8.08
RS85042	5.20	9.0	9.8	9.4	8.35
Shirley	5.0	9.0	10.3	11.4	8.93
RS84065	4.5	7.8	9.4	9.8	7.88
Dario	4.9	10.3	9.4	9.8	8.60
Novy	5.4	8.1	11.4	10.8	8.93
B366	5.2	8.4	10.3	10.3	8.55
Mean	4.93	8.43	9.81	10.13	8.33

Luddington EHS

Variety trial Physical appearance

Table 59 Fruit quality - fruit length (shape)*

Variety	Week 30	32	34	36	Mean
Counter	2.29	2.71	2.36	2.05	2.35
Criterium	2.79	2.52	2.22	1.62	2.29
Turbo	2.14	2.34	1.72	1.76	1.99
662	2.50	2.52	2.22	1.86	2.28
663	2.57	2.57	1.86	1.67	2.17
W690	2.43	2.43	2.29	2.29	2.36
W1007	2.29	2.86	2.43	2.00	2.40
2015	2.36	2.10	2.50	2.00	2.24
Goldstar	1.79	2.24	2.00	1.76	1.95
RS85042	2.17	2.28	2.22	1.76	2.10
Shirley	2.29	1.62	2.07	1.81	1.95
RS84065	2.36	2.24	1.86	1.71	2.04
Dario	2.75	3.14	2.34	1.62	2.46
Novy	1.93	1.43	1.00	1.41	1.44
B366	2.00	1.33	1.22	1.63	1.55
Mean	2.31	2.29	2.02	1.80	
SED	0.264	0.206	0.242	0.235	
LSD		*0.422	*0.519	*0.481	
		**0.569	**0.720	**0.649	
		***	***1.001	***	
Sig.	ns	***	***	***	
	(sig. at p = 0.07)				

* Where 2 = round, 0 = flatter fruit, 4 = longer fruit

***sig. diff between varieties at 0.1% level

Luddington EHS

Variety trial Physical appearance

Table 60 Fruit quality - boxiness (score 0-4)

Variety	Week 30	32	34	36	Mean
Counter	0	0	0	0.10	0.03
Criterium	0	0.05	0.07	0	0.03
Turbo	0	0	0	0	0
662	0	0	0	0	0
663	0.07	0	0	0	0.02
W690	0	0	0	0	0
W1007	0	0	0	0	0
2015	0	0	0	0	0
Goldstar	0	0	0	0.05	0.01
RS85042	0	0	0.07	0	0.02
Shirley	0.22	0.05	0	0.24	0.13
RS84065	0	0	0.14	0	0.04
Dario	0.93	2.19	2.43	1.95	1.88
Novy	0.15	0.05	0	0	0.05
B366	0.07	0.10	0	0.33	0.13
Mean	0.10	0.16	0.18	0.18	
SED	0.177	0.172	0.211	0.273	
LSD	*0.380	*0.352	*0.453	*0.559	
	**0.527	**0.475	**0.628	**0.754	
	***0.733	***0.632	***0.874	***1.003	
Sig.	***	***	***	***	

***sig. diff between varieties at 0.1% level

Luddington EHS

Variety trial Physical appearance

Table 61 Fruit quality - ribbing (score 0-4)

Variety	Week 30	32	34	36	Mean
Counter	0.15	0.24	0.43	0.19	0.25
Criterium	0.22	0.62	0.43	0.43	0.42
Turbo	0.29	0.48	0.43	0.19	0.35
662	0	0.14	0.29	0.19	0.16
663	0.07	0.24	0.07	0.67	0.26
W690	0	0.19	0.14	0.43	0.19
W1007	0	0.14	0.29	0.24	0.17
2015	0	0.14	0	0	0.04
Goldstar	0	0.10	0.22	0.29	0.15
RS85042	0	0.33	0.29	0.29	0.23
Shirley	0.15	0.57	0.15	0.19	0.26
RS84065	0	0.48	0.50	0.57	0.39
Dario	1.50	1.52	2.52	2.62	2.04
Novy	1.65	2.33	1.29	2.09	1.84
B366	0.36	0.90	0.50	0.51	0.57
Mean	0.29	0.56	0.50	0.59	
SED	0.255	0.178	0.168	0.256	
LSD	*0.547	*0.365	*0.360	*0.524	
	**0.759	**0.492	**0.500	**0.707	
	***1.056	***0.654	***0.696	***0.941	
Sig.	***	***	***	***	

* **sig. diff between varieties at 0.1% level

Luddington EHS

Variety trial Physical appearance

Table 62 Fruit quality - nippling (score 0-4)

Variety	Week 30	32	34	36	Mean
Counter	0.43	0.14	0	0	0.14
Criterium	0.86	0.14	0	0	0.25
Turbo	0.36	0	0	0	0.09
662	1.07	0.09	0	0.05	0.30
663	0.43	0.19	0	0.09	0.18
W690	0.29	0.14	0	0	0.11
W1007	0.07	0.19	0	0	0.07
2015	0.07	0	0	0	0.02
Goldstar	0	0	0	0	0
RS85042	0	0	0	0	0
Shirley	0.22	0	0	0	0.05
RS84065	0.07	0	0	0	0.02
Dario	0.79	0.81	0.07	0.14	0.45
Novy	0	0.05	0	0	0.01
B366	0	0	0	0	0
Mean	0.31	0.117	0.00	0.02	
SED	0.274	0.174	0.254	0.557	
LSD	*0.588	*0.356	0.545	1.141	
	**0.816	**0.481			
		***0.639			
Sig.	**	***	NS	NS	

** sig. diff between varieties at 1% level

*** " " " " " 0.1% "

Luddington EHS

Variety trial Physical appearance

Table 63 Fruit quality - fine net cracking (score 0-4)

Variety	Week 30	32	34	36	Mean
Counter	0.15	0.52	0.43	0.76	0.46
Criterium	0.15	0.24	1.22	0.76	0.59
Turbo	0.07	0.09	1.29	0.52	0.49
662	0.57	0.81	1.57	1.00	0.99
663	0.07	0.81	1.86	1.00	0.94
W690	0.36	0.33	1.50	0.85	0.76
W1007	0.43	0.81	1.79	1.14	1.04
2015	0.50	0.14	0.72	1.09	0.61
Goldstar	0.79	0.95	2.64	1.19	1.39
RS85042	1.02	0.91	2.00	1.38	1.33
Shirley	0.07	0.05	0.43	0.19	0.19
RS84065	1.64	1.00	1.43	1.48	1.39
Dario	0	0	0.07	0.14	0.05
Novy	0	0	0	0	0
B366	0	0.05	0.36	1.55	0.49
Mean	0.39	0.45	1.15	0.87	
SED	0.161	0.381	0.590	0.494	
LSD	0.345	*0.780	*1.266	1.012	
Sig.	NS	*	*	NS (sig. at p=0.07)	

*sig. diff between varieties at 5% level

Luddington EHS

Variety trial Physical appearance

Table 64 Fruit quality - radial cracking (score 0-4)

Variety	Week 30	32	34	36	Mean
Counter	0.22	0.33	1.72	1.10	0.87
Criterium	0.93	0.52	0.79	0.29	0.63
Turbo	0.15	0.38	0.50	0.24	0.32
662	1.07	0.33	0.57	1.00	0.74
663	0.07	0.38	0.50	1.14	0.52
W690	0.29	0.52	0.93	0.43	0.54
W1007	0.72	1.76	1.43	0.47	1.10
2015	0.43	0	0.50	0.53	0.37
Goldstar	0.50	0.67	0.57	1.05	0.70
RS85042	0.91	0.43	0.50	0.24	0.52
Shirley	0.15	0.05	0.22	0	0.10
RS84065	1.50	1.67	1.07	1.10	1.34
Dario	0	0.10	0.54	0.10	0.19
Novy	0	0.24	0	0.11	0.09
B366	0	0.48	0.22	0.52	0.31
Mean	0.46	0.52	0.67	0.55	
SED	0.407	0.257	0.540	0.373	
LSD	*0.873	*0.526	1.158	*0.764	
		**0.710			
		***0.944			
Sig.	*	***	NS	*	

* sig. diff between varieties at 5% level

*** " " " " 0.1% "

Luddington EHS

Variety trial Physical appearance

Table 65 Fruit quality - goldspot (score 0-4)

Variety	Week 30	32	34	36	Mean
Counter	2.64	2.52	2.36	3.14	2.67
Criterium	2.36	2.57	3.43	3.38	2.94
Turbo	2.86	2.57	2.93	2.43	2.70
662	2.50	1.95	3.00	2.38	2.46
663	3.22	2.48	3.36	3.62	3.17
W690	2.72	2.67	2.93	3.33	2.91
W1007	3.22	3.05	2.86	2.95	3.02
2015	2.58	2.43	3.08	3.00	2.77
Goldstar	3.00	2.76	3.72	3.91	3.35
RS85042	2.59	2.43	3.00	2.62	2.66
Shirley	2.36	1.67	1.50	2.29	1.96
RS84065	2.79	2.90	3.50	3.57	3.19
Dario	1.99	2.48	2.97	3.24	2.67
Novy	1.22	1.38	1.15	1.99	1.42
B366	1.79	1.14	1.71	2.06	1.68
Mean	2.52	2.33	2.76	2.93	
SED	0.319	0.340	0.404	0.345	
LSD	*0.684	*0.696	*0.867	*0.707	
	**0.950	**0.939	**1.203	**0.953	
		***1.249	***1.672	***1.268	
Sig.	**	***	***	***	

** sig. diff between varieties at 1% level

*** " " " " " 0.1% "

Source of fruit and method whereby the sap was extracted from cherry tomatoes, 1987

Date			Refractometer reading	Reducing sugar (g/100ml)
1/7	Gardeners Delight	Frozen and pressed after thawing (F & P)	5.7	4.06
		Macerated (M)	5.6	4.04
		Hand squeezed (HS)	5.0	3.91
	Sweet 100	F & P	8.7	6.18
		M	8.3	6.31
		HS	8.5	5.90
9/7	Gardeners Delight	F & P	6.3	4.01
		M	6.5	4.00
		HS	6.5	3.23
	Sweet 100	F & P	8.5	6.09
		M	8.5	5.56
		HS	8.8	5.06
15/7	Gardeners Delight	F & P	6.7	4.13
		M	7.4	4.63
		HS	6.5	4.83
	Sweet 100	F & P	8.7	5.78
		M	9.0	6.18
		HS	7.8	5.34
22/7	Gardeners Delight	F & P	6.5	4.45
		M	6.7	4.48
		HS	6.9 Drop	
			6.5 Collective	3.90
	Sweet 100	F & P	8.5	5.28
		M	8.4	5.23
		HS	9.3 D	
			8.5 C	4.86
31/7	Yates 32	F & P	4.6	2.51
		HS	5.0 D	
			5.5 C	2.37
	Yates 33	F & P	5.1	3.67
		HS	4.7 D	
			5.2 C	3.13
	Sweet Chelsea	F & P	5.2	3.43
		HS	5.5 D	
			5.0 C	3.28
	Cherita	F & P	6.4	4.28
		HS	6.7 D	
			5.3 C	3.06

			Refractometer reading	Reducing sugar (g/100ml)
31/7 (cont'd)	Harry's Delight	F & P	5.2	3.79
		HS	6.7 D	
			4.6 C	2.72
	Sweet 100	F & P	6.2	3.75
		HS	6.5 D	
			5.4 C	3.23
	Sidlesham A	F & P	6.1	4.80
		HS	6.1 D	
			5.6 C	4.25
	Sidlesham B	F & P	6.1	4.51
		HS	7.5 D	
			5.4 C	3.69
	Sidlesham C	F & P	5.9	3.99
		HS	6.6 D	
			5.6 C	4.07
	Sidlesham D	F & P	5.2	3.23
		HS	5.4 D	
			4.7 C	2.98
	Sidlesham E	F & P	5.6	3.56
		HS	5.8 D	
			5.0 C	3 46
5/8	St Michael G.D.	F & P	5.5	3.13
		M	5.3	3.24
		HS	5.7 D	
			5.5 C	3.16
	Sainsbury, Guernsey	F & P	5.7	4.22
		M	5.0	3.34
		HS	5.2 D	
			4.3 C	2.93
27/8	Cherita	F & P	5.8	3.40
		M	6.0	3.31
		HS	6.6 D	
			6.2 C	3.35
	Gardeners Delight	F & P	7.0	4.70
		M	7.5	5.18
		HS	7.2 D	
			7.7 C	4.79
	Sidlesham A	F & P	5.6	3.56
		M	6.2	4.20
		HS	7.7 D	
			6.4 C	4.10
	Sidlesham E	F & P	6.1	3.97
		HS	6.7 D	
			6.0 C	3.88

			Refractometer reading	Reducing sugar (g/100ml)
28/8	Yates 32	F & P	5.2	3.26
		HS	5.3 D	
			5.7 C	2.33
	Yates 33	F & P	5.9	3.59
		HS	5.4 D	
			6.0 C	2.99
	Sweet Chelsea	F & P	5.4	3.81
		HS	5.5 D	
			5.7 C	3.41
	Cherita	F & P	6.1	3.89
		HS	5.9 D	
			6.3 C	3.28
	Harry's Delight	F & P	5.3	3.30
		HS	6.0 D	
			5.8 C	2.72
	Gardeners Delight	F & P	5.6	3.53
		HS	6.0 D	
			5.9 C	3.60
	Sweet 100	F & P	6.2	3.52
		HS	7.2 D	
			6.7 C	3.06
	Sidlesham D	F & P	6.4	4.48
		HS	7.4 D	
			6.7 C	3.88
	Sidlesham F	F & P	6.2	3.94
		M	6.2	
		HS	6.0 D	
			6.2 C	3.81
	Sidlesham G	F & P	5.8	3.84
		M	5.7	3.98
		HS	6.2 D	
			5.9 C	3.64
21/9	Gardeners Delight	F & P	7.0	4.88
		HS	7.0 D	
			6.3 C	4.59