



Horticulture Research International, Stockbridge House, Cawood, Selby, N.Yorks.

PROJECT REPORT

To:
Horticultural Development Council
18 Lavant Street
Petersfield
Hants, GU32 3EW

**Protected Celery: Green Celery
Variety Trial**

October 1995

Commercial – In Confidence

Authentication

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

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ANNUAL REPORT

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Contents

	Page
Relevance to Growers and Practical Application	5-6
Introduction	7
Objectives	8
Materials and Methods	8-12
1. Varieties	
2. Plant Spacing	
3. Cultural Details	
4. Experimental Design	
5. Records	
6. Explanation of Statistical Analysis	
Results	13-27
Propagation Assessments	
Harvest Data, Yield, Quality, Stick Size	
Grower and Supermarket Assessments	
Discussion	28-31
Conclusions	32
Acknowledgements	33
Appendix I: Experimental Design	34
Appendix II: Soil Analysis	35
Appendix III: Weather Data	36
Appendix IV: Height and weight of sticks trimmed to the knuckle	37

Relevance to Growers and Practical Application

- * Claudius looks to be the most promising variety as used commonly in commerce.
- * TZ9145 was also good and is recommended for further commercial evaluation.
- * There appeared to be no benefit from growing at the wider spacing for supermarket outlets.
- * High levels of soil nutrients led to high quality and good shelf life for most varieties.
- * Bolting was a severe problem for Norgreen, Profi and Ramon.

A comparison of 13 green celery varieties grown at two plant spacings at HRI Stockbridge House, for harvesting in May was conducted. A white variety (Celebrity) was also included for comparison, for growers not familiar with new green varieties.

<u>Varieties</u>	<u>Seed Companies</u>
1. Avalon	}
2. Bolivar	}
3. Ramon	}
	Elsoms
4. Claudius	}
5. Victoria	}
6. TZ9145	}
7. TZ9388	}
	Tozer
8. Celebrity (white)	}
9. Greenlight	}
10. Multipak	}
11. Norgreen	}
12. FM1219	}
	Nickerson
13. Profi	}
14. E227	}
	Enza

Plant Spacing

9" x 9" (19.75 plants/m²), standard commercial spacing
9" x 10" (17.78 plants/m²)

Sown: 15 December
Planted: 24 February
Harvest: 18 May

Harvest: 18 May (trimmed to 30 cm length for supermarket outlets).

Variety	Marketable Weight (Cl.I+II)(g)		% Cl.I (as a mean of both spacings)	% Cl.II	% Waste
	HD*	LD*			
TZ9145	505	550	96	0.0	4.3
Victoria	504	541	91	2.2	6.6
Greenlight	473	521	93	1.5	5.1
Claudius	465	480	99	1.5	0.0
TZ9388	461	502	99	0.0	0.0
FM1219	460	513	97	0.7	2.1
Bolivar	456	501	87	0.0	12.2
Avalon	453	478	85	0.0	15.1
Celebrity	452	479	99	0.8	0.0
Multipak	437	473	99	0.0	0.7
E227	428	458	98	0.8	1.5
Variety Significance	***		***	NS	***
Profi	385	435	13	1.4	85.5
Ramon	384	431	37	0.7	62.0
Norgreen	365	406	33	0.7	66.7
Variety Significance	***		*	NS	***
Spacing Significance	*		NS	NS	NS

* HD = High Density 9" x 9" spacing
 LD = Low Density 9" x 10" spacing

Introduction

The area of protected celery in England and Wales in 1992 was 159 ha (MAFF Census), with the main production areas being the South East, East Anglia, Lancashire, and Yorkshire. The gross value of the industry in 1992 was £5.2 million.

White celery has been traditionally grown under protection to fill the slot between the cessation of imports in April and the start of the outdoor production in early July. Both supermarkets and processors are now asking for 'green' celery as opposed to the traditional white. Green celery is now available from UK outdoor production and from imports from Spain and the USA.

In the last 18 months green celery varieties with the potential to be grown under protection in the UK have become increasingly available. There is, however, a lack of information on their resistance to bolting and produce quality in terms of colour, stick shape, weight, length, leaf canopy and thickness. The requirements of the market outlets also needs to be evaluated. This trial compared 13 green celery varieties. A white celery variety 'Celebrity' was included as a benchmark. At an Open Day growers, seed companies and retailers were invited to view the trial and assess each variety. This report summarises these assessments and statistical analysis of yield and quality.

Objectives

1. To conduct a comparison of 13 green celery varieties grown at two plant spacings at HRI Stockbridge House, for harvesting in May.

A white variety was also included for comparison, for growers not familiar with new green varieties.

2. To invite producers, seed companies, supermarkets and processors to an Open Day to view the trial and conduct assessments.
3. To select varieties for further investigation of cultural requirements for Year 2.

Materials and Methods

1. Varieties

<u>Varieties</u>		<u>Seed Companies</u>
1. Avalon	}	
2. Bolivar	}	Elsoms
3. Ramon	}	
4. Claudius	}	
5. Victoria	}	Tozer
6. TZ9145	}	
7. TZ9388	}	
8. Celebrity (white)	}	
9. Greenlight	}	
10. Multipak	}	Nickerson
11. Norgreen	}	
12. FM1219	}	
13. Profi	}	Enza
14. E227	}	

2. Plant Spacing

1. 9" x 9" (19.75 plants/m²), standard spacing used in commerce.
2. 9" x 10" (17.78 plants/m²).

3. Cultural Details

Propagation

Sown: 15 December. Seeds were sown onto the surface of a peat based compost in seed trays but not covered with compost. A propagation temperature of 21°C day and night with supplementary tungsten light between 0800 hours and 1600 hours was maintained throughout early propagation prior to pricking out.

Pricking Out: 11 January. Plants were pricked out into 43 mm peat blocks at the first true leaf stage. One week after pricking out the temperature was gradually reduced to 18°C day and night, and one week prior to planting-out further reduced to 16°C day and night.

Planting Out: 24 February. Planting-out was carried out at the five to sixth true leaf stage.

Propagation Temperatures (day and night):

15 December	21°C
18 January	18°C
21 February	16°C

Fungicides during Propagation: Aaterra at 20 g/m³ of compost for Pythium control, incorporated into the peat blocks prior to pricking-out.

Cropping House

Soil Type: Sandy loam.

Fertiliser Requirement: No base dressing of fertiliser was required prior to planting as nutrient levels were high enough (see Appendix II). To improve the soil condition mushroom compost had been thoroughly incorporated into the soil prior to cropping.

Dry Nitrogen Feeds:

10 March - Ammonium nitrate (Nitram) top dressing at 24 g/m² (3/4 Oz/yd²) placed down alternate rows.

3 April - Ammonium nitrate top dressing at 24 g/m² (3/4 Oz/yd²) placed down alternate rows.

20 April, 27 April, 4 May - Liquid feed using Ammonium nitrate at 100 g/l water at a 1:200 dilution, and washed off the leaves afterwards.

Cropping House Temperatures (day and night):

24 February	14°C, Vent 18°C
27 February	12°C, Vent 21°C
2 March	10°C, Vent 21°C
22 April	8°C, Vent 19°C
24 April	6°C, Vent 17°C
28 April	5°C, Vent 16°C

Pesticide Applications - Post-planting

Planting Date: 24 February

1. Methiocarb as Draza (for slug control) at planting and repeated at second nitram top dressing.
2. Prometryn as Gesaguard 2 weeks (post-planting herbicide).
3. Cypermethrin as Ambush C x 2 (for aphids) between planting and harvest.
4. Carbendazim as Bavistin x 1 (for sclerotinia) between planting and harvest.

4. Experimental Design

Fourteen fully guarded beds were available for the trial which were divided into 7 plots to provide a 7 x 14 design. Varieties were randomised across the 14 beds and spacing applied to the 7 'complete' rows (see Appendix I, Design).

Harvest Date: 18 May

5. Records

Mean marketable stick weight (g).

Mean stick height cut to the knuckle (cm).

Stick quality (% Class I, II and waste).

Size grading:

% Class I <400 g

% Class I 400-500 g

% Class I >500 g

Propagation visual assessments.

Pre-planting visual assessments.

Harvest visual assessments to include:

stick shape, colour, leaf canopy characteristics, petiole thickness and ribbing, stringiness and flavour.

Supermarket and marketing organisation, shelf life, quality and flavour assessments.

Soil analysis prior to planting and prior to liquid feeding.

Environmental data of cropping house.

Results

Propagation Visual Assessments

During propagation in seed trays there were some noticeable differences in the speed at which different varieties germinated. Claudius, TZ9388 and Profi were particularly fast to germinate, whereas Multipak was slower. Multipak also gave the poorest stand of seedlings.

Three weeks after pricking out, leaf stage, height and uniformity was assessed. All varieties were around the 2-3 true leaf stage by 30 January. Multipak and Norgreen, however, had noticeably smaller true leaves. Claudius and FM1219 were slightly leggier than other varieties in terms of plant height/habit. Both Claudius and Bolivar were the most uniform in plant size at this stage (30 January). Victoria and Norgreen produced the most variable plants.

Table 1: Overall Visual Assessments (score 0-5, 0 = poor, 5 = good)

	Final Germination	Leaf Stage (no. true leaves)	Plant Habit#	Uniformity+
Avalon	4	3	4	4
Bolivar	3	3	4	5
Celebrity	4	2	4	3
Claudius	5 Fast	3	3	5
Greenlight	5	2	4	3
Multipak	2 Slow	2 Small	4	3
Norgreen	3	2 Small	4	2
Profi	5 Fast	3	4	4
Ramon	5	2	4	4
Victoria	3	2	4	2
E227	5	2	4	4
FM1219	4	2	3	3
TZ9145	5	3	4	3
TZ9388	5 Fast	3	4	4

Plant Habit: 5 = stout, 0 = leggy

+ Uniformity: 5 = uniform, 0 = uneven

Pre-planting Visual Assessments 24 February

Claudius had the most true leaves at planting, and Multipak, Norgreen and FM1219 had the least true leaves.

Bolivar, TZ9145 and TZ9388 produced the tallest plants at over 9 cm while the plants of Multipak were the shortest at 4 cm at planting. The width of the largest leaf was also measured for each variety. TZ9145 and TZ9388 produced the largest leaves and Multipak the smallest.

Table 2: Assessment of Celery at Planting 24 February 1995

Variety	Leaf No.	Height (cm)	Size of Largest Leaf (cm)
Avalon	6	6.5	6
Bolivar	6	9.5	6
Celebrity	6	5.5	4.5
Claudius	7	8	6
Greenlight	6	5	5
Multipak	5	4	3
Norgreen	5	6	4.5
Profi	6	7	6.5
Ramon	6	6.5	6
Victoria	6	8	5.5
E227	6	7.5	4.5
FM1219	5	7	6
TZ9145	6	10.5	7
TZ9388	6	9	7

Marketable Yield and Quality

The crop was harvested on 18 May and trimmed to a length of 30 cm to meet supermarket specifications. TZ9145, Victoria, and Greenlight were the heaviest varieties at both spacings and E227 the lightest (Table 3).

Table 3: Harvest: 18 May (trimmed to 30 cm length for supermarket outlets).

Variety	Marketable Weight (Cl.I+II)(g)		% Cl.I (as a mean of both spacings)	% Cl.II	% Waste
	HD*	LD*			
TZ9145	505	550	96	0.0	4.3
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Spacing Significance	*		NS	NS	NS

* HD = High Density 9" x 9" spacing
LD = Low Density 9" x 10" spacing

For the purpose of statistical analysis 3 varieties which had a high proportion of bolting plants (Norgreen, Profi, and Ramon), were analysed separately to the 11 'non-bolting' varieties. This provides a more accurate form of analysis on the 11 'non-bolting' varieties. Norgreen, Profi and Ramon had extremely low percentage Class I sticks due to bolting and therefore over 65% of these plants were waste (Table 3). Stick quality of most of the 11 non-bolting varieties was good. Avalon, Victoria and Bolivar had some reduction in the number of Class I sticks due to some bolting and heart breakdown (Table 3).

Stick Size Variability

Celery supplied to supermarkets is generally required to have a minimum stick weight of 400 g, whereas processors buy on total tray weight. Therefore for processing, the larger the stick, the fewer that are required to fill a 9 kg tray. The proportion of sticks in three size categories (<400 g, 400-500 g, and >500 g) was calculated at the two spacings to investigate variability within varieties. Planting at the lower density decreased the percentage of sticks below 400 g, increased the percentage above 500 g but had little effect on the percentage between 400 g to 500 g weight compared to the higher density.

Multipak and E227 produced generally smaller sticks in the <400 g and 400-500 g grade and less in the >500 g grade. TZ9145 and Victoria produced heavier sticks in the >500 g and 400-500 g grade and few in the <400 g grade.

Table 4: Stick size - Harvest 18 May.

Variety	% of Sticks in Each Grade					
	<400 g		400-500 g		>500 g	
	HD*	LD*	HD	LD	HD	LD
TZ9145	17	8	34	34	46	62
Victoria	16	8	32	30	48	66
Greenlight	21	11	45	43	32	48
Claudius	25	14	46	47	28	40
TZ9388	33	16	35	36	31	48
FM1219	24	12	40	41	35	49
Bolivar	27	12	43	45	29	45
Avalon	30	14	49	50	21	36
Celebrity	26	14	50	47	23	39
Multipak	37	18	44	46	20	33
E227	37	21	47	48	18	28
Variety Significance	**		*		***	
Profi	68	42	38	42	0.1	0.2
Ramon	54	35	42	41	10	17
Norgreen	77	55	22	22	6	13
Variety Significance	NS		NS		NS	
Spacing Significance	***		NS		***	

* HD = High Density 9" x 9" spacing
 LD = Low Density 9" x 10" spacing

Descriptive Notes of Varieties on 16 May 1995

Avalon Dark green foliage, leaflets quite narrow and deeply cut. Stick apple green, closed. 7 ribs to a petiole. Looks reasonable but now showing some bolting. Stronger flavour than TZ9145.

Bolivar Very dark green foliage, leaflets narrow, deeply cut. Variety is shorter in height than the majority. Stick shiny, slightly darker green than apple green, closed. 5 ribs. Looks uniform. Good, sweet flavour. Looks interesting although there is some bolting now showing.

Claudius Foliage a shade darker than mid green. Leaflets broad and less cut, similar to the leaves of Celebrity. Stick apple green, closed. 7 ribs. Looks good. Flavour sweet and juicy but not too strong. Very little stringiness.

Greenlight Mid green foliage. Leaflet size and shape similar to Claudius. Sticks apple green, somewhat open with some distorted growth - petioles growing out from the main stick. Poor quality in appearance, fairly strong taste, a bit stringy.

Multipak Foliage a shade darker than mid green. Leaflets broad and less cut. Shorter in height than the majority - similar to Celebrity. Sticks shiny apple green, closed. 7 ribs. Possibly too small? - the petioles are thinner than most, stringy, reasonably strong flavour and after-taste.

Norgreen Dark green foliage, very big leaflets, deeply cut. Tallest of all the varieties. Sticks apple green. 7 ribs. Mild, bland flavour. Severe bolting problems.

Profi Very dark green foliage. Leaflets narrow and deeply cut. Sticks a shade darker than apple green, shiny, closed. 6 ribs. Thinner petioles than Victoria. Reasonably sweet flavour, very little stringiness. Signs of bolting though.

Ramon Dark green foliage. Leaflets narrow and deeply cut. Sticks a shade darker than mid green, shiny. 8 ribs. Severe bolting problems.

Victoria Mid green foliage, taller than Multipak. Leaflets narrow and deeply cut. Sticks shiny apple green. 8 ribs. Slightly open, relatively thin petioles. Moderate flavour, no strong after-taste.

E227 Dark green foliage, shortest of all the varieties. Leaflet size and shape like Claudius. Sticks a shade darker than apple green, closed. 7 ribs. Narrow petioles. Fairly bland flavour.

FM1219 Foliage slightly darker than mid green. Leaflets narrow and finely cut. Has the odd bent petiole. Sticks a shade darker than apple green, closed. 7 ribs. Strong initial taste but no strong after-taste. Looks uniform, looks interesting.

TZ9145 Mid green foliage. Leaflets reasonably broad, not deeply cut. Sticks apple green, closed. 8 ribs. Now showing slight bacterial rot. Mild pleasant, sweet taste. Looks good.

TZ9388

Mid green foliage, leaflet size and shape similar to Claudius. May be too many small sticks in it? Sticks a shade lighter than apple green, dull looking, closed. 8 ribs. Fairly bland taste and stringy.

Most Interesting: Bolivar, Claudius, FM1219, TZ9145.

Variety Assessments

Grower Assessment

A grower assessment carried out at the Celery Open Day scored each variety 0-5 for overall usefulness. The higher the score the better the variety. Claudius, Celebrity (White Control) and FM1219 were the first three most preferred varieties. Norgreen, Profi and Ramon had signs of bolting and were positioned last (Table 5).

Table 5: Celery Grower Assessment of Overall Usefulness.

Variety	Mean Score*	Rank*
Claudius	3.44	1
Celebrity	3.38	2
FM1219	3.00	3
Victoria	2.81	4
TZ9388	2.63	5
E227	2.57	6
TZ9145	2.50	7
Multipak	2.38	8
Avalon	2.13	9
Greenlight	2.13	9
Bolivar	1.25	11
Profi	0.50	12
Norgreen	0.38	13
Ramon	0.38	13

* Score: 0 = poor, 5 = excellent

* Rank in order of preference

Supermarket/Marketing Organisation Assessment

Appearance

Avalon and E227 were dark green varieties, and Claudius, TZ9145, Victoria and Celebrity light green. All other varieties were judged intermediate.

Victoria and Profi had the best shaped sticks whereas Celebrity and TZ9388 the worst.

For overall appearance Profi, Avalon and Victoria were chosen first, second and third to be acceptable appearance, whereas Claudius, FM1219, Bolivar and TZ9388 were considered to be poor.

Flavour

The strongest flavoured varieties were Claudius, Avalon and E227, and the weakest flavour were Victoria, Bolivar and Celebrity. Most varieties ranged between moderate to pronounced bitterness in flavour, but Victoria was only slightly bitter.

The sweetness of TZ9145, Multipak and Claudius was noticeably greater than other varieties. Most varieties were only slightly sweet but the former were moderately sweet to taste.

Varieties with the best overall flavour were Victoria, Celebrity, Avalon and TZ9388. FM1219 had the poorest flavour.

Texture

Celebrity, TZ9388 and FM1219 were the most stringer varieties and Profi, Claudius and Victoria the least stringy.

TZ9145 was noticeably crisper and Greenlight softer than most other varieties.

The moisture content of Profi and E227 was higher in taste tests, whereas Claudius had a relatively dry eating quality.

The overall eating texture of TZ9145 and Avalon was the best, but FM1219 and Greenlight were poor. Most varieties were judged as acceptable.

Key to supermarket / marketing organisations assessments

Score	1	2	3	4	5
<u>Appearance</u>					
Colour	white	yellow	light green	dark green	apple green
Shape	mishapen, thin splayed petioles	***	***	***	close, thick straight petioles
Overall appearance	off putting	poor	acceptable	good	ideal
<u>Taste</u>					
Flavour strength	bland	weak	moderate	strong	very strong
Bitterness	none	slight	moderate	pronounced	extreme
Sweetness	none	slight	moderate	pronounced	extreme
Overall Taste	off putting	poor	acceptable	good	ideal
<u>Texture</u>					
Stringiness	none	slight	moderate	fibrous	extremely fibrous
Crispness	rubbery	soft	firm	crisp	brittle
Moisture	dry	moist	juicy	very juicy	watery
Overall texture	off putting	poor	acceptable	good	ideal

Table 6 : Supermarket / marketing organisations assessments
(SEE KEY FOR SCORES)

Appearance

Variety	Colour	Shape		Overall Appearance		
		Rank	Rank	Rank	Rank	
Avalon	4.2	1	2.5	8	3.1	2
Bolivar	4.0	3	3.8	4	2.3	9
Celebrity	3.0	12	1.5	11	2.5	5
Claudius	3.6	9	2.5	8	2.3	9
Greenlight	4.0	3	3.8	3	2.5	5
Multipak	3.8	8	3.2	5	2.7	4
Profi	4.0	3	4.0	1	3.3	1
Victoria	3.3	11	4.0	1	3.0	3
E227	4.1	2	2.9	6	2.3	7
FM1219	4.0	3	2.5	8	2.3	9
TZ9145	3.6	9	2.6	7	2.3	7
TZ9388	4.0	3	1.3	12	2.0	12

Taste

Variety	Flavour Strength		Bitterness	Sweetness	Overall taste			
	Rank	Rank			Rank	Rank		
Avalon	3.5	2	3.5	1	1.5	10	3.0	2
Bolivar	2.8	10	3.5	1	1.8	6	2.3	9
Celebrity	2.5	12	2.3	10	1.8	6	3.0	2
Claudius	3.8	1	3.5	1	2.1	3	2.5	6
Greenlight	3.3	4	3.5	1	2.0	4	2.5	6
Multipak	3.0	5	2.8	8	2.3	2	2.5	6
Profi	3.0	5	3.5	1	1.3	11	2.0	10
Victoria	2.8	10	1.5	12	1.8	6	3.3	1
E227	3.3	3	3.0	7	2.0	4	2.0	10
FM1219	3.0	5	3.5	1	1.3	11	1.8	12
TZ9145	3.0	5	2.5	9	2.5	1	2.7	5
TZ9388	3.0	5	2.3	10	1.8	6	3.0	2

Texture

Variety	Stringiness		Crispness		Moisture		Overall texture	
	Rank	Rank	Rank	Rank	Rank	Rank	Rank	
Avalon	3.0	7	3.3	2	2.5	3	3.3	2
Bolivar	3.3	5	3.0	4	2.3	7	2.3	9
Celebrity	3.8	1	3.0	4	2.5	3	3.0	3
Claudius	2.8	10	3.0	4	1.5	12	3.0	3
Greenlight	3.0	7	2.4	12	2.0	11	2.0	11
Multipak	3.3	5	2.8	9	2.4	6	3.0	3
Profi	2.8	10	3.0	4	3.0	1	2.3	9
Victoria	2.3	12	2.8	9	2.3	7	2.5	8
E227	3.0	7	3.0	4	2.7	2	3.0	3
FM1219	3.5	2	2.8	9	2.3	7	2.0	11
TZ9145	3.3	4	4.0	1	2.5	3	3.3	1
TZ9388	3.5	2	3.3	3	2.3	7	2.8	7

Marketing Organisation Taste Tests (Table 7)

Claudius, Victoria and Bolivar had the best score for preferred colour for green celery. Celebrity, the white control variety, was a pale apple green colour and had a low score as expected. TZ9145 and Multipak however also had a low colour score.

Bolivar and E227 had the best texture and Celebrity and Multipak the worst.

Bolivar, E227 and Claudius had the best flavour and were ranked first, second and third overall based on colour, texture and flavour (see Table 7).

**Table 7: Results of Taste Test on 11 Samples (17.05.95)
(average figures).**

Variety	Colour	Texture	Flavour	Total	Rank
Bolivar	3.5	3.5	3.3	3.4	1
E227	3.3	3.5	3.2	3.3	2
Claudius	3.5	3.2	3.0	3.2	3
Victoria	3.7	3.3	2.5	3.2	4
FM1219	3.3	3.3	2.3	3.0	5
Greenlight	3.2	3.3	2.5	3.0	5
TZ9388	3.3	2.5	2.3	2.7	7
Avalon	3.2	2.7	2.0	2.6	8
TZ9145	2.7	2.7	2.3	2.5	9
Celebrity	2.8	2.2	2.3	2.4	10
Multipak	2.7	2.3	2.0	2.3	11

Shelf Life (Marketing Organisation Assessment)

Sticks were placed into bags and put in shelf life conditions at 8-10°C. Sticks were individually weighed when put into the shelf life room and weighed after 4, 6 and 11 days to calculate percentage fresh weight loss. Avalon and Claudius were less susceptible to weight loss, losing 5-6% after 11 days. Other varieties tended to lose similar percentage weights (7-10%) after 11 days in shelf life conditions (Table 8). A larger sample size would be necessary to confirm these initial results.

Table 8: Shelf Life (percentage fresh weight loss).

Variety	4 days	6 days	11 days
Avalon	2.2	3.4	5.8
Bolivar	4.9	6.2	8.4
Celebrity	3.7	5.3	8.1
Claudius	2.1	3.1	5.2
Greenlight	3.4	5.1	9.1
Multipak	3.7	5.7	16.7
Victoria	2.5	4.3	6.2
E227	3.5	4.8	7.5
FM1219	3.9	6.2	11.0
TZ9145	5.3	7.2	10.2
TZ9388	3.3	4.2	6.3

Discussion

High base nutrients in the soil throughout the course of the trial resulted in high quality sticks with good shelf life. Varieties were assessed and recorded at propagation, harvest and the marketing stage. An opinion on the market requirements can be obtained through supermarket and marketing organisation assessments. Flavour preference, however does vary between the supermarket and marketing organisation tests due to the personal and subjective nature of flavour testing. Information on appearance and preferred texture was more consistent and very useful. The performance of each variety is described as follows:

Avalon - Produced sticks around 453 g at harvest when grown at the standard spacing. There was 15% waste with this variety as it had started to bolt. It had dark green, narrow and deeply cut foliage with apple green petioles. In supermarket assessments it was ranked highly for its appearance, strong flavour and overall eating texture. In shelf life conditions Avalon was less susceptible to fresh weight loss than other varieties.

Bolivar - During propagation plants of Bolivar were tall, but uniform. It produced sticks with an average weight of 456 g at the standard spacing, but increased stick weight of 45 g to 501 g at the wider spacing. 12% of sticks were waste due to bolting. Bolivar had a weak flavour in the first supermarket assessment but was chosen to have the most preferred flavour, texture and ranked highly for colour in other supermarket taste tests.

Celebrity (white variety used for reference) - Produced good quality sticks around 452 g in weight at the standard spacing. It produced uniform plants with a high percentage of sticks in the 400-500 g range. In grower assessments it was picked as the second most preferred variety. It produced a weak flavour with very little bitterness and moderate sweetness, and therefore was ranked highly for overall taste. Celebrity produced fairly stringy sticks which were crisp and moist. In the second supermarket taste tests Celebrity was judged against the requirements of the market for green varieties and was ranked poorly for colour, texture and flavour.

Claudius - Produced sticks of 465 g of excellent quality at the standard spacing. In propagation plants of Claudius were particularly fast to germinate, were uniform and had the most true leaves at planting. Growers picked Claudius as the best variety at the open day. Sticks were of a light apple green colour, with a strong but sweet flavour in supermarket assessments. Claudius was ranked third highest in taste tests for overall flavour, texture and colour. Sticks of Claudius had the best shelf life abilities, having the lowest loss in fresh weight over 11 days.

Greenlight - Was one of the heaviest varieties with average stick weight of 473 g at the standard spacing (9 x 9") and 521 g at the wider spacing. There was some downgrading to Class II and waste due to shape and heart breakdown. Growers ranked the variety fairly low in order of preference mainly due to its shape/habit. Supermarket assessments picked this variety as average for appearance and taste but poorly for texture due to its softness. Sticks of Greenlight in shelf life were poor losing above average fresh weight.

Multipak - During propagation was slower to germinate and subsequently was a smaller plant, with the least true leaves at planting. At harvest sticks of Multipak were lighter than average but of good quality. Multipak produced a high percentage of small sticks below 400 g at the standard spacing (9" x 9"). Petioles were slightly thinner than other varieties but of a shiny apple green colour. Sticks had a noticeably sweet flavour similar to Claudius, but were only average in supermarket assessments for appearance and overall taste. Multipak was however scored third for overall texture. Sticks lost the most fresh weight in shelf life and were generally softer than average.

Norgreen - During propagation plants were slow to germinate, small and variable. The average marketable stick weight was low as a high proportion (67%) of sticks had bolted. This variety had dark green, deeply cut large leaflets. Growers ranked the variety low due to the severe bolting problems.

Profi - Average marketable stick weight was low due to a high proportion (85%) of sticks which had bolted. The variety was ranked low by growers due to its bolting. Sticks had a sweet taste with very little stringiness.

Ramon - Produced a high percentage (62%) of waste due to bolting and had therefore a low average marketable weight. The bolting problem of this variety meant it was ranked low in preference by growers.

Victoria - During propagation produced more variable plants than average. Victoria was one of the heaviest varieties at both spacings, but with some downgrading to Class II and waste due to shape and some heart breakdown. A high proportion of sticks of Victoria were over 500 g in weight. Growers scored Victoria better than average although due to its extra height more trimming is required (see Appendix IV). Petioles were a light apple green colour of generally good shape. In supermarket assessments Victoria scored highly for overall appearance and taste but below average for texture.

E227 - Produced the lightest weight of stick from the 11 'non-bolting' varieties but good quality. Plants had dark green foliage and were the shortest of all varieties. E227 produced dark green sticks with a strong flavour and high moisture content in supermarket assessments. In taste tests E227 was ranked highly for texture and flavour.

FM1219 - During propagation this variety produced fairly tall plants but with fewer true leaves at the time of assessment (Table 1). The mean marketable weight of 460 g per stick at the standard plant spacing and high percentage Class I meant it was ranked highly by growers. In supermarket assessments FM1219 was considered poor for overall appearance, taste and texture, and in taste tests was average. It has a distinctive strong initial taste, but weak aftertaste. Slightly higher than average fresh weight loss was recorded in shelf life conditions with this variety.

TZ9145 - Produced the heaviest mean marketable stick weight (505 and 550 g) when grown at the standard and wide plant spacings. Stick quality was generally good with a small percentage of waste due to heart breakdown. Apple green petioles and mid green foliage, supermarkets ranked TZ9145 average for appearance. Sticks were chosen for best overall texture by supermarkets, due to its crispness and moisture content. In taste tests TZ9145 was below average. Shelf life for sticks of TZ9145 in terms of fresh weight loss was generally below average.

TZ9388 - During propagation plants of TZ9388 were particularly fast to germinate, producing tall, large leaved plants at planting. TZ9388 produced sticks with a good marketable weight (461 g) at the standard spacing and excellent quality. There was some variability in size with approximately one third of sticks in each of the three size grades, (less than 400 g, 400-500 g, and above 500 g), when grown at the standard spacing. TZ9388 was ranked poorly for appearance but highly for overall flavour in supermarket assessments. This variety was average in shelf life, taste tests and grower assessments.

Conclusions

1. Claudius performed well in yield, quality, shelf life, and taste tests and was overall one of the best varieties in this trial.
2. TZ9145 produced heavy sticks of generally good quality. Supermarkets ranked it highly for texture, crispness and moisture content, and was worthy of further trialing.
3. Victoria produced good quality, heavy sticks with good overall appearance and taste but average texture and increased levels of trash due to its height (see Appendix IV).
4. FM1219 performed well in terms of yield and Class I and was ranked highly in grower assessments. It has a distinctive strong initial taste with weak aftertaste but was judged as poor for the taste and texture in supermarket assessments.
5. TZ9388 produced sticks of good weight but slightly variable in size. Overall flavour was good.
6. Good levels of soil nutrients produced high quality sticks with good shelf life for most varieties. Bolting however was a severe problem for 3 varieties (Norgreen, Ramon and Profi). Bolting was less of a problem but still present in Avalon and Bolivar.
7. There was no significant advantage to grow at the wider spacing for most varieties.

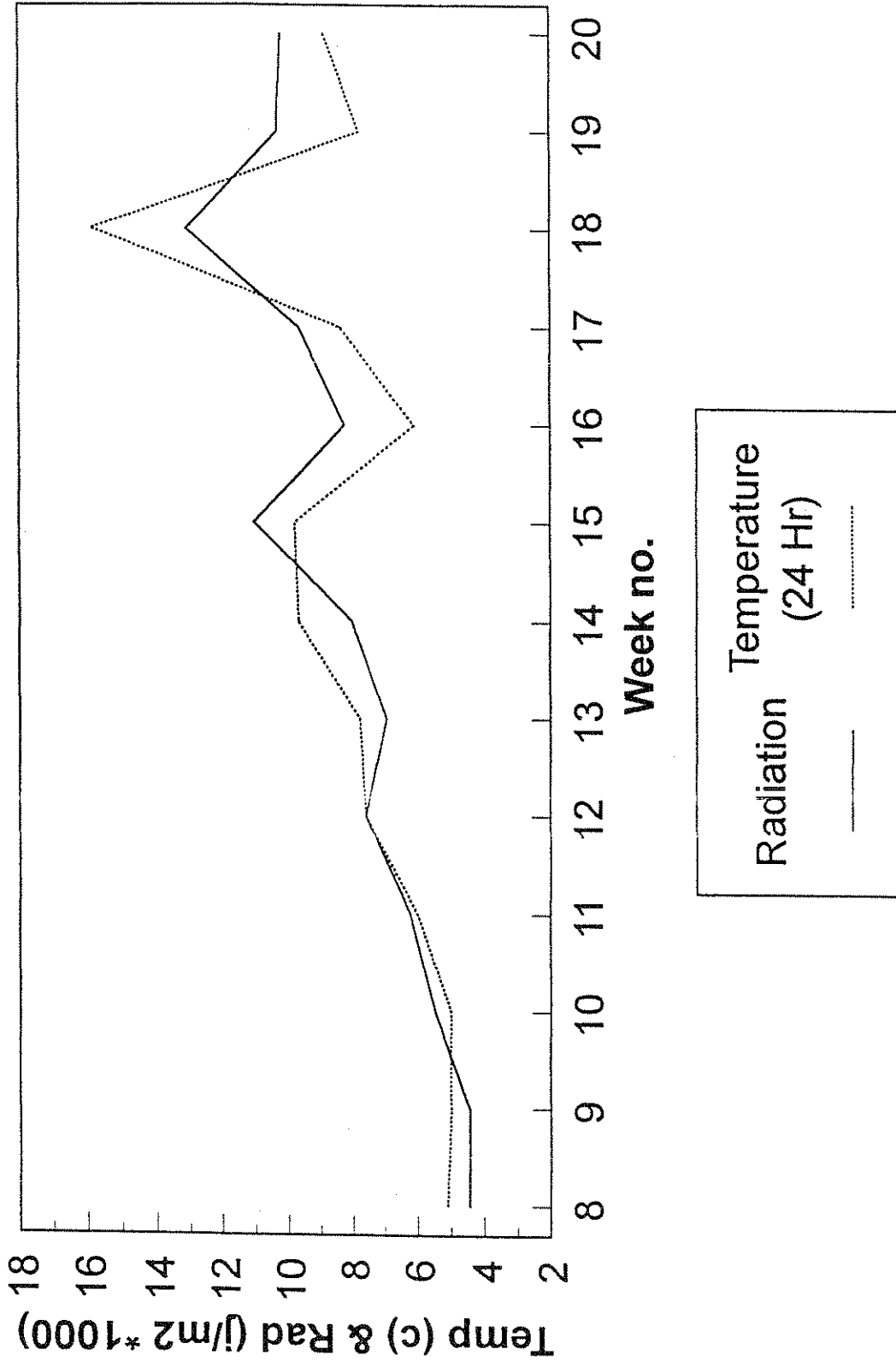
Acknowledgements

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APPENDIX II: SOIL ANALYSIS

	15 February	5 April
pH	6.6	6.6
EC	2860 mSiem	2570 mSiem
NO ₃ Nitrogen	74 ppm	93 ppm
NH ₃ Nitrogen	8 ppm	4 ppm
Phosphorus	130 ppm	128 ppm
Potasssium	750 ppm	800 ppm
Magnesium	343 ppm	274 ppm
Boron	2.6 ppm	-

Weather data



APPENDIX IV: HEIGHT AND WEIGHT OF STICKS TRIMMED TO THE KNUCKLE

Height and weight of sticks trimmed to the knuckle
 Weight data from replicate 1 only

Variety	Height	Weight cut to knuckle (g)	Weight cut to 30 cm (g)
Avalon	31.7	503	430
Bolivar	31.7	488	413
Celebrity	31.7	461	401
Claudius	31.1	544	466
Greenlight	33.9	505	469
Multipak	31.4	466	400
Victoria	37.4	606	471
E227	33.4	495	410
FM1219	33.3	506	431
TZ9145	31.9	540	456
TZ9388	33.6	513	459