

HDC CONTRACT R & D - EXPERIMENT REPORT

HDC FV2/C87/0354/2

LEEKS - EXTENSION OF THE MARKETING SEASON THROUGH STORAGE AND EARLY
PRODUCTION TECHNIQUES. STORAGE OF LEEKS

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

Project Leader: Dr M R Shipway, Luddington Experimental Horticulture
Station, Stratford-on-Avon, Warwickshire CV37 9SJ. Tel: 0789 750601.

Status of work: second year completed

Year of experiment: 2

Report Number: 2

Period covered: April 1988-July 1988

Abstract

The object of this trial was to extend the marketing season for leeks into the May/June period. Leek varieties Porino and Cortina were sown in the field in May 1987 and lifted on 11 April 1988. They were lightly trimmed and placed vertically into ventilated crates for storage at 0-1°C, 95% RH.

The effect of Controlled Atmosphere (CA) (9% CO₂, 3% O₂ storage) was compared with normal refrigerated air storage, together with the effects of a benomyl spray on quality of the leeks out of store and during a subsequent shelf life period.

Samples were removed from the air store after 6, 7, 8 and 9 weeks and from the CA store after 7, 8, 9 and 10 weeks.

Storing leeks in a Controlled Atmosphere improved the quality over air storage, both when removed from store and during subsequent shelf life. CA produced a higher marketable yield with less rotten and fewer bolted leeks. In shelf life, CA stored leeks were more turgid and flower stalks were less extended.

When assessed over a storage period of 7-10 weeks the quality of CA stored leeks deteriorated after more than 9 weeks. However, even after 9 weeks storage, 87 per cent of those put into store were still marketable.

In contrast, the quality of air stored leeks significantly deteriorated after 6 weeks although little further deterioration developed over the next 3 weeks.

Sensory appraisal indicated that the leeks from both store environments were still of good eating quality at the end of the maximum storage period.

In contrast to 1987 a benomyl spray, pre-storage, was not beneficial in improving the quality of leeks out of either air or CA storage.

The two varieties Cortina and Porino appeared to store equally well although, as might be expected, the grade out when removed from store reflected the inherent characteristics of each variety.

Cortina, the longer shanked type, produced a higher percentage of 20-28 mm diameter leeks whilst Porino, a shorter shanked type, higher percentages of the larger size grades.

Further work is required to evaluate new varieties, to investigate methods for reducing the labour costs and to clarify the influence of a fungicidal pre-storage treatment over a range of seasons.

Objective

To investigate the storage techniques required to provide the market with quality leeks during the period from mid May to early July.

Introduction

Given the year round demand from all market outlets for good quality leeks and the previous unavailability of such a product from UK sources during May, June and July, this project was initiated to investigate the potential and the best conditions for long term (over four weeks) storage. Results from the first year of this project indicated that storage in Controlled Atmospheres improved the quality of the leeks over that of air stored leeks. After ten weeks storage over 70 per cent of the leeks in store were still of marketable quality although trimming losses were fairly high by this stage and shelf life was reduced.

The use of a benomyl treatment (either spray or dip) was shown to substantially improve the quality of leeks stored in air although the benefits were less marked in CA. The trial was repeated in 1988 to verify these results and to gain a greater understanding of the effects of CA and fungicide treatments.

Materials and methods

Two varieties of winter hardy leeks, Porino and Cortina, were grown to provide a crop suitable for harvesting in April.

The crop was drilled in May 1987. The very mild weather during the 1987/88 winter period encouraged the growth of the leeks during this period. Crop maturity was therefore advanced more than usual in spring 1988. Harvesting commenced two weeks earlier than planned (11 April), since flowering and bolting were already initiated.

The leeks were lifted, lightly trimmed (outer leaves, roots and tops) and stored vertically (tops uppermost) in ventilated crates (approximately 90 leeks/crate). Leeks which were diseased, soft or <20 mm diameter were discarded as unmarketable.

Treatments

- Variety: 1. Porino
 2. Cortina
- Store environment: a. Air, 0-1°C; 95% RH
 b. CA, 0-1°C; 95% RH 9% CO₂, 3% O₂,
- Fungicide: 1. None
 2. Water spray
 3. Benomyl spray (Benlate 1g/l).
- Storage duration: Air store; 6, 7, 8, 9 weeks
 CA store; 7, 8, 9, 10 weeks.

Benlate and water treatments were given as a thorough spray over the top of the crates.

Stores were loaded and sealed on 14 April. At each of the appropriate removal dates crates were removed and the leeks trimmed to a supermarket-type prepack specification, i.e. 10 cm flag above the lowest split, 20 mm diameter.

Assessments

A pre-storage assessment of the crop was made at the time of harvest. Individual crates of leeks were weighed into store and re-weighed on removal from store. Following trimming the marketable leeks were size graded (20-28, 29-35, 35-45 and 45+ mm) and unmarketable leeks classified according to their defects (undersized, floppy, rots and bolters). Any leek in which the flower stalk was clearly visible was considered to have bolted.

At the time of loading into store and at each of the removal dates a sample of good quality leeks was assessed under shelf life conditions of 20°C and 50% RH. Ten trimmed leeks from each treatment were cleaned, packed into shallow trays and overwrapped. Weight loss, disease on shank and flag and turgidity were recorded at 24 hour intervals over a three day period. Leeks were cut open at the end of the shelf life period and any internal rot or flower stalk extension similarly recorded. All shelf life assessments (except weight loss) were scored on a 9-0 scale, where 9 was excellent.

In addition, a sensory appraisal of the leeks was carried out by the Campden Food and Drink Research Association to determine the eating quality of stored leeks. (Full details of the assessments are given in Appendix I).

Statistical analysis

Three replicated crates of each storage treatment were randomised within each removal date in the stores. Shelf life assessments were also carried out on the same three replicates randomised in the shelf life room. Statistical analysis was undertaken by Andrew Mead at IHR Wellesbourne. Percentage calculations have been subjected to angular transformation for improved statistical analysis. Bracketed figures in the tables refer to the untransformed data. Where interactions between treatments are significant they have been noted. (V = variety, S = store type, R = removal date).

Results and discussion

RESPONSE TO CONTROLLED ATMOSPHERES

Initial observations on the leeks removed from the CA and air stores suggested that those from the CA store were of better quality after equivalent periods in store. In particular it was noticeable that very little grey mould had developed on the cut leaf surfaces. Assessments on removals after 7 (31/5), 8 (6/6) and 9 (13/6) weeks in store confirmed that the leeks stored under CA produced a higher marketable yield (by number), with less rotten leeks and fewer leeks which had bolted. (Tables 1 to 3).

Table 1 Percentage marketable leeks, by number. Mean of varieties. (Bracketed figures the untransformed data)

Store	Removal (weeks in store)			Mean
	7	8	9	
Air	76 (60.7)	82 (65.2)	79 (62.8)	79 (62.9)
CA	87 (69.6)	85 (67.3)	87 (68.8)	86 (68.5)
Mean	81.5 (65.1)	83.5 (66.2)	83 (65.8)	
SED (between removal dates) 1.001 ns (70 df)				
SED (between stores) 0.817*** (70 df)				
Removal x store interaction***				

Table 2 Percentage unmarketable, by number of rots Mean of varieties

Store	Removal (weeks in store)			Mean
	7	8	9	
Air	9.6 (17.4)	6.5 (14.6)	7.8 (15.6)	8.0 (15.8)
CA	3.9 (9.2)	3.5 (10.2)	3.9 (11.2)	3.8 (10.2)
Mean	6.8 (13.3)	5.0 (12.4)	5.9 (13.4)	5.9
SED (between removal dates)		0.946 ns (70 df)		
SED (between stores)		0.772*** (70 df)		

Where ns = not significant * = significant at p = 0.05
 ** = " " p = 0.01
 *** = " " p = .001

Table 3 Percentage unmarketable by number due to bolters. Mean of three removals (31/5, 6/6 and 13/6)

Store	Variety		Mean
	Cortina	Porino	
Air	10.6 (18.72)	13.5 (20.37)	12.0 (19.55)
CA	6.3 (14.11)	7.6 (15.73)	7.0 (14.92)
Mean	8.4 (16.41)	10.5 (18.05)	
SED (between varieties)		0.696* (70 df)	
SED (between stores)		0.696*** (70 df)	

The benefits of using a Controlled Atmosphere for the storage of leeks were also seen in the shelf life assessments. Although all leeks were trimmed to pre-pack standards before they were put into the shelf life room the leeks which had been stored under CA developed less disease on the flags and shanks, were more turgid and lost less weight during the shelf life period than those stored in air. Flower stalk extension was also less advanced in the CA stored leeks. (Table 4).

Table 4 Shelf life assessments after 72 hours. Mean of 3 removals (31/5, 6/6 and 13/6)

Store	Disease on shanks scored 9-0	Disease on flags	Turgidity	Flower stalk extension	% weight loss
Air	8.57	8.07	7.50	5.54	2.32
CA	8.70	8.24	7.81	6.01	2.15
SED (70 df)	0.044**	0.048**	0.057***	0.114***	0.047***

Measurements of the extent to which the leeks produced extension growth whilst inside the pre-pack also indicate that CA stored leeks are less prone to grow after packing (Table 5).

Table 5 Average extension growth (mm) on leeks 3 days after packing

Store	Weeks in store			Mean
	7	8	9	
Air	19	15.5	21	18.5
CA	10	6.5	11	12.5

RESPONSE TO TIME IN STORE

The 1987 storage trial indicated that leeks stored in air would not maintain their quality as long as those stored in CA. In the 1988 trial, therefore, the first removal from the air store was made a week earlier than from the CA store.

Air store

The quality of air stored leeks was better after six weeks storage than at any subsequent removal. The numbers of marketable leeks were greater, there were less undersized and bolted leeks than at later removals from store (Tables 6, 7 and 8). There were, however, few differences between removals after 7, 8 and 9 weeks in store.

Table 6 Percentage marketable by number

Store	Removal (weeks in store)					Mean
	6	7	8	9	10	
Air	86.3 (68.5)	75.8 (60.7)	82.2 (65.2)	78.9 (62.8)		80.8 (64.3)
CA		87.4 (69.6)	84.6 (67.3)	86.7 (68.8)	74.6 (60.2)	83.3 (66.5)
SED (between removals) (70 df)						
Air store	1.31** *					
CA store	1.43***					

Table 7 Percentage unmarketable, by number, undersized. Air store only

Store	Removal (weeks in store)					Mean
	6	7	8	9	10	
Air	0.1 (0.34)	1.7 (5.66)	0.8 (3.05)	1.3 (4.27)		1.0 (3.33)
SED (between removals) 1.436** (70 df)						

Table 8 Shelf life assessments after 72 hours - Air store only

Removal (weeks in store)	Score 9-0 (where 9 = excellent)		
	Disease on shank	Disease on flag	Flower stalk initiation
6	8.78	8.26	6.11
7	8.67	8.22	5.88
8	8.53	8.12	5.50
9	8.52	7.88	5.24
Mean	8.63	8.12	5.68
SED (70 df)	0.087*	0.100**	0.154***

Table 9 Percentage unmarketable, by number, due to bolters

Store	Removal (weeks in store)					Mean	
	6	7	8	9	10		
Air	7.0(14.2)	12.5(20.5)	11.9(18.4)	11.7(19.8)		10.8(18.2)	
CA		7.0(14.9)	6.5(14.5)	7.3(15.3)	11.3(19.3)	8.0(16.0)	
Mean		9.8(17.7)	9.2(16.5)	9.5(17.6)			
SED (between removals)							
Air store	1.567** (70 df)					SED (between stores)	0.696*** (70 df)
CA store	0.937** (70 df)						

The results from this trial indicate that the highest yields following storage were obtained after six weeks, when 86 per cent of leeks loaded into store were of marketable quality, after trimming, out of store. It is important to note however that even after nine weeks, 79 per cent of the leeks were still of a marketable quality.

Shelf life assessments on good quality marketable leeks also indicate that the storage period affects quality. Leeks stored for more than seven weeks showed more disease on the shank, and flower stalk extension was more advanced throughout shelf life. Disease on the flag was also worse on leeks stored for more than eight weeks (Table 10).

CA store

With CA storage a significant reduction in the quality of leeks was not recorded until the fourth removal, after 10 weeks in store. At this last removal the percentage of marketable leeks was reduced in comparison to earlier removals, the number of bolted leeks had increased and more leeks were too flaccid (or floppy) to be acceptable (Tables 6, 9 and 10). Leeks in CA therefore appeared to store well for up to nine weeks with 87 per cent still marketable when removed from store and retrimmed.

Table 10 Percentage unmarketable, by number, due to softness/floppiness - CA store

Variety	Removal date (weeks in store)				Mean
	7	8	9	10	
Cortina	1.6 (4.12)	5.3 (10.84)	1.7 (5.19)	16.0 (22.32)	6.2 (10.62)
Porino	0.3 (1.34)	4.2 (8.11)	1.0 (3.14)	2.6 (7.61)	2.0 (5.05)
Mean	1.0 (2.73)	4.8 (9.47)	1.4 (4.16)	9.3 (14.96)	
SED (between removals)	2.303*** (70 df)				
SED (between varieties)	1.628*** (70 df)				

Although leeks used in shelf life assessments were all trimmed and were of good marketable quality, differences between removal dates were still apparent in the assessments made. Disease on the shank of the leeks was worse on leeks stored for 10 weeks, and was worse on the flags of leeks stored for more than 8 weeks. The turgidity of leeks held for 10 weeks was also less than those removed earlier. Differences in the extent to which the flower stalk had extended inside the leeks were also noted (Table 11).

Table 11 Shelf life assessments after 72 hours. CA store only

Removal (weeks in store)	Scored 9-0 (where 9 = excellent)			
	Disease on shank	Disease on flag	Turgidity	Flower stalk extension
7	8.74	8.36	7.77	6.48
8	8.67	8.31	8.01	5.87
9	8.69	8.04	7.64	5.68
10	8.49	7.97	7.54	6.72
Mean	8.65	8.17	7.74	6.19
SED (70 df)	0.056***	0.079***	0.075***	0.196***
Interactions	V x R*			

INFLUENCE OF VARIETY

The two varieties, Cortina and Porino, used in the trial are known from NIAB variety trials to differ in their size and form.

Cortina: (Blue-green type). A dark green flagged leek with medium length shank showing some bulbing. For January-March production.

Porino: (Blue-green winter type). A short shanked variety with some bulbing and a very dark green flag. For January-early May production.

These varieties were shown to differ also in the grade out after storage. There were no significant differences in the numbers of marketable leeks brought out of store. However Cortina produced a higher percentage of undersized and floppy leeks, but less bolters (Table 12). Of particular interest when meeting supermarket specifications, Cortina produced a higher percentage of marketable leeks in the 20-28 mm size category (Table 13). In contrast Porino, the shorter shanked variety produced less undersized and floppy leeks but also less in the 20-28 mm category.

Table 12 Percentage of unmarketable, by number, because undersized. Mean of 4 store removals

Store	Variety	
	Cortina	Porino
Air	1.1 (4.06)	0.8 (2.60)
CA	1.2 (4.65)	0.5 (1.94)
SED (between varieties)		
Air store	1.015 ns	
CA store	0.951** (70 df)	

Table 13 Percentage of marketable leeks, by number, in 20-28 mm size grade. Mean of 4 store removals

Store	Variety	
	Cortina	Porino
Air	38.1 (38.04)	28.2 (31.17)
CA	38.3 (37.89)	23.6 (28.84)
SED (between varieties)		
Air store	0.955*** (70 df)	
CA store	1.102*** (70 df)	

Some of these varietal characteristics were also seen in the shelf life assessments. Cortina, the 'thinner' variety, was less turgid during shelf life (Table 14) but in contrast the amount of disease on the flag was generally less than the levels which developed on Porino. (Table 15).

Table 14 Turgidity score after 72 hours shelf life

Store	Variety	
	Cortina	Porino
Air	7.24	7.68
CA	7.64	7.85
SED (between varieties)		
Air store	0.082*** (70 df)	
CA store	0.053*** (70 df)	
Interactions	V x T *	

Table 15 Disease score on leek flag after 72 hours shelf life

Store	Variety	
	Cortina	Porino
Air	8.24	8.00
CA	8.22	8.12
SED (between varieties) (70 df)		
Air store	0.071***	
CA store	0.056 ns (p = 0.09)	
Interactions	V x R *	

EFFECT OF FUNGICIDE TREATMENTS

In contrast to the results from 1987, the water and fungicide treatments did not appear to influence the quality of leeks removed from store. There is, however, some weak evidence of an effect on the shelf life quality of the leeks. The benomyl spray reduced disease levels during shelf life on leek flags and to a lesser extent on the shanks in comparison to water treated or untreated leeks (Table 16).

Table 16 Shelf life assessments after 72 hours. Mean of three removals from CA and air store

Treatment	Score 9-0 (where 9 = excellent)		
	Disease on shank	Disease on flag	Turgidity
Control	8.65	8.12	7.75
Benomyl	8.69	8.26	7.64
Water	8.56	8.08	7.56
SED (70 df)	0.054 ns (p=0.06)	0.058**	0.070*
Interactions	T x S *		

Sensory appraisal

Details of the methods used to assess the leeks using sensory appraisal (taste test) are given in Appendix I. The leeks were sent to Campden Food and Drink Research Association as listed on the schedule (Table 17). Results did not indicate there were any significant differences between the different removal dates from store. As might be expected the frozen sample did differ in some characteristics from the fresh (stored) samples (Tables 18 and 19).

At the end of the trial both air and CA stored leeks at their last removal were still of good quality. The leeks were moderate to fairly green in colour, slightly white and slightly to moderately bright in colour. The strength of flavour was fairly weak in the green portion of the stems but slightly stronger in the white portion. These taste characteristics had changed very little from the initial assessments.

Table 17 Assessment times of fresh leeks

Weeks in store	Treatment	Date of testing
1	Fresh Frozen	22 April
6	Air store Frozen	27 May
7	CA store Air store Frozen	3 June
8	CA store Air store Frozen	10 June
9	CA store Air store Frozen	16 June
10	CA store Frozen	24 June

Table 18 Sensory appraisal of leeks - differences between treatments at each removal date

Treatment		Colour					Flavour	
		Green	White	Yellow	Grey	Bright	Green strength	White strength
Week 1	Fresh	3.3	2.6	2.1	2.2	2.4	2.6	3.2
	Frozen	3.2	2.7	1.3	1.7	3.2	2.3	3.3
Week 6	Air	3.7	2.1A	2.0	1.8	3.3	2.8A	3.7
	Frozen	2.7	3.3B*	1.6	2.3	3.0	2.0B*	2.8
Week 7	CA	3.9A	2.0A	1.4B*	1.9B**	3.2B**	2.7	3.4
	Air	3.1B*	2.4	2.4A	1.8B**	3.0B*	2.8	3.2
	Frozen	3.2	3.0B***	1.2B**	2.9A	2.1A	2.7	3.4
Week 8	CA	3.6	2.1A	1.8B*	1.7B*	3.3B**	2.8	3.3
	Air	3.3	2.2A	2.4B***	2.0	2.9B*	2.9B*	2.7
	Frozen	2.9	3.2B*	1.0A	2.8A	2.1A	2.1A	2.7
Week 9	CA	3.8	2.2	2.4	2.4	2.7	2.9	3.0
	Air	3.0	2.6	2.8A	2.1	2.4	2.6	3.2
	Frozen	3.3	3.2	1.3B*	2.2	3.0	2.2	2.8
Week 10	CA	3.9A	1.9A	1.8	1.6	3.2	3.3	3.8
	Frozen	2.8B**	3.3B*	1.6	2.0	2.8	2.3	2.9
Overall mean		3.3	2.6	1.8	2.1	2.8	2.6	3.2

Confidences of differences from Control.

(Confidences are per column of 18 treatments based on Fisher's Modified LSD procedure).

* 95%

** 99%

*** 99.9%

Table 19 Sensory appraisal of leeks

Treatment	Colour					Flavour	
	Green	White	Yellow	Grey	Bright	Green strength	White strength
Fresh							
Week 1	3.3	2.6	2.1	2.2	2.4	2.6	3.2
CA storage							
Week 7	3.9	2.0	1.4	1.9	3.2	2.7	3.4
Week 8	3.6	2.1	1.8	1.7	3.3	2.8	3.3
Week 9	3.8	2.2	2.4	2.4	2.7	2.9	3.0
Week 10	3.9	1.9	1.8	1.6	3.2	3.3	3.8
Mean	3.8	2.1	1.9	1.9	3.1	2.9	3.4
Air storage							
Week 6	3.7	2.1	2.0	1.8	3.3	2.8	3.7
Week 7	3.1	2.4	2.4	1.8	3.0	2.8	3.2
Week 8	3.3	2.2	2.4	2.0	2.9	2.9	3.3
Week 9	3.0	2.6	2.8	2.1	2.4	2.6	3.2
Mean	3.3	2.3	2.4	1.9	2.9	2.8	3.4
Frozen control							
Week 1	3.2	2.7	1.3	1.7B	3.2B	2.3	3.3
Week 6	2.7	3.3	1.6	2.3	3.0B	2.0	2.8
Week 7	3.2	3.0	1.2	2.9AC	2.1A	2.7	3.4
Week 8	2.9	3.2	1.0	2.8A	2.1A	2.1	2.7
Week 9	3.3	3.2	1.3	2.2	3.0B	2.2	2.8
Week 10	2.8	3.3	1.6	2.0D	2.8	2.3	2.9
Mean	3.0	3.1	1.3	2.3	2.7	2.3	3.0

Confidences of differences in Control.

(Confidences are per column of 18 treatments based on Fisher's Modified LSD procedure).

* 95%

** 99%

*** 99.9%

Conclusions

1. Storing leeks in a Controlled Atmosphere (CA) of 9% CO₂, 3% O₂, at 0-1°C compared with air at 0-1°C, improved the quality both when removed from store and during subsequent shelf life.
2. Results from two years trials indicate that leeks could be successfully held in CA for up to 8-9 weeks and in air for up to 6-7 weeks. Quality begins to deteriorate significantly beyond these storage periods.
3. Choice of leek variety will affect the grade out and shelf life characteristics of the leeks out of store. Longer shanked varieties with a smaller diameter such as Cortina are more suitable for prepacks but trimming after storage may likely result in undersized leeks. Thinner shanked leeks may also suffer due to a lack of turgidity.
4. In contrast to the previous seasons trial a Benlate spray before storage was not shown to significantly improve the quality of leeks out of store.
5. Leeks were still of good eating quality after 9 weeks air storage or 10 weeks CA storage. Flavour had not noticeably deteriorated during storage.

Recommendations for future action

1. The work should continue in order to verify the benefits of using CA storage of leeks to supply the market in the period May to early July.
2. The use of fungicides pre-storage should be further assessed to identify whether their use confers any advantages in either air or CA storage.
3. New leek varieties which stand well over the winter and produce a reliable crop in mid April should be assessed for storage potential.
4. An investigation into techniques to reduce the labour costs of trimming stored leeks.

Exploitation of findings

Results confirmed in both the first and second year of this trial may be used as guidelines for the commercial use of this technique.

Methods for sensory appraisal and sugar analysis

Leeks variety Cortina were harvested on 11 April and put into CA and air stores. Table 1 shows the times of removal from store when samples were sent to CFPRA for tasting. On each occasion the samples were packed and overwrapped, put into the shelf life room at Luddington for 48 hours before delivery on the afternoon of the second day. They were tasted the following morning. The first samples tasted (week 1) were freshly harvested from the field.

Control samples

At each tasting a sample of frozen leeks was assessed to act as a control. These frozen leeks were from a single batch of variety Cortina frozen on 12 April.

Preparation and cooking

Large leeks (diameter approximately 45 cm) were selected. The tops were removed from the leeks at the point where the leaves divide and roots were trimmed off. Each leek was cut into 1" pieces. They were washed to remove dirt, but not peeled.

Fresh leeks were cooked for 11 minutes and frozen leeks for 4 minutes in boiling salted water.

Quality assessment

Three samples of each treatment were tasted and assessed using the 'QAV' method of sensory appraisal and the scoring system in Table 2. Overall colour was assessed and flavour of white and green portions were rated separately.

Scoring system for quality appraisal of leeks

	Score				
	1	2	3	4	5
COLOUR					
Amount of colours (green, white/ cream, yellow, grey)	Very slight	Slight	Moderate	Consid- erable	Very large
Brightness	Dull	Slightly dull	Moderately bright	Very bright	Extremely bright
FLAVOUR					
Strength of leeks	Moderately weak	Fairly weak	Slightly weak	Slightly strong	Moderately strong
Sweet	Not at all	Slightly	Moderately	Very	Extremely
Bitter	Not at all	Slightly	Moderately	Very	Extremely
TEXTURE					
Firmness	Very soft	Moderately soft	Slightly soft	Slightly firm	Very firm
Fibrousness	Not at all	Slightly	Moderately	Very	Extremely

Observations during shelf life

cv. PORINO Pre-storage 19/4/88

The leeks when placed into shelf life were disease free and turgid. Very little disease development on the flags, generally only chlorosis of the outer leaves, some areas deteriorating. The leeks remained fairly turgid throughout the period of assessment although the thinner leeks were more inclined to become soft in the shank. The quality of all three treatments was very good at the end of the assessment period and there were no visible differences between the treatments.

Internally all leeks showed flower development, with nearly half very well developed and a few already bolted. No breakdown.

Leeks extended 2 cm.

cv. CORTINA

The leeks when placed into shelf life were disease free and turgid. Very little disease developed, the flags had minor chlorosis with some deterioration of the outer leaves. The leeks remained fairly turgid throughout the assessment period, the thinner leeks became soft in the shank. The quality of all three treatments was very good at the end of the assessment period and there were no visible differences between treatments.

Internally all leeks showed flower development, with half very well developed and some already bolted (twice as many as Porino). No breakdown.

Leeks extended 2 cm.

Removal 1: Air store 24/5/88 (six weeks)

CORTINA: Control colour 138A/B

0 hours: Pale mid green. No disease on shank or flag. Fairly turgid, some light finger pressure taken.

24 hours: Pale mid green. Minor rot on shank. Slight chlorosis on flag. Fairly turgid but some softening.

48 hours: Mid green. Minor rots on shank. Slight chlorosis, few areas of rot on outer leaves. Softening, some remain quite turgid.

72 hours: Mid green. Rot and mould growth on few shanks. Flags chlorosis with some rots. Outer leaves shrivelling. Soft with collapse of some tissue causing ridges. Leeks extended 2.7 cm.

Internal assessments

Out of store: Flower stems already well elongated, with the flower heads starting to form. No breakdown.

After 3 days SL: Flower stems thickened and elongated. Flower heads well formed, half were bolting. No rots.

CORTINA: Benlate colour 138A/B
0 hours: Pale to mid green. No disease on shank or flag. Quite turgid, some take light finger pressure.
24 hours: Pale to mid green. No disease on shank. Flag minor chlorosis on outer leaves. Fairly turgid, slight finger pressure taken.
48 hours: Pale mid green. Minor discoloration on bulb. Slight chlorosis on outer leaves of flag. Some softening but generally quite turgid.
72 hours: Pale mid green. Minor discoloration on bulbs. Flags slight chlorosis, minor spots of rot. Softening, few have cells collapsing. Leeks extended 2.5 cm.

Internal assessments

Out of store: Flower stems elongated with some flower heads well formed, few already bolted. No breakdown.

After 3 days SL: Most have thick, elongated flower stems. Flower heads formed on half, few bolted. No rots.

CORTINA: Water colour 138B

0 hours: Pale mid green. No disease on shank, very minor spots of chlorosis on a few flags. Fairly turgid, slight finger pressure taken.

24 hours: Pale mid green. Slight orange discolorations on bulbs. Some chlorosis on flags. Leeks softening a little.

48 hours: Pale mid green. Orange patches on blanch and bulb. Chlorosis on outer leaves of flag, some minor rots. Softening.

72 hours: Pale mid green. Orange patches, slight mould growth on a couple. Chlorosis and some rotting on outer flag leaves. Soft, some leek cells collapsed. Leeks extended 2.7 cm.

Internal assessments

Out of store: Flower stems thickened and elongated. Flower heads well formed on over half. No rots.

After 3 days SL: Flower stems thickened and elongated. Some flower heads formed, couple bolting. No rots.

Removal 1 Air store 24/5/88 (6 weeks)

PORINO: Control colour 138A

0 hours: Pale-pale mid green. No disease on shank. Slight chlorosis on some flags. Fairly turgid.

24 hours: Pale mid green. Minor orange patches on bulb and shank. Chlorosis and minor rot on outer leaves of flag. Slight softening, quite turgid.

48 hours: Mid green. Orange patches, minor rots developing on shank. Chlorosis on outer leaves of flag, slight rots. Quite turgid, some softening.

72 hours: Mid green. Mould growth on areas of rot. Chlorosis and rotting on outer leaves of flag. Softening. Leeks extended 1.5 cm.

Internal assessments

Out of store: Flower stems elongating, some flower heads formed. No rots.

After 3 days SL: Flower stems thickened and elongated. Flower heads formed.
One third were bolting. No rots.

PORINO: Benlate colour 138A

0 hours: Pale to mid green. No disease on shank. Minor chlorosis on outer leaves of flags. Fairly turgid.

24 hours: Pale to mid green. No disease on shank. Slight chlorosis on outer leaves of flags. Fairly turgid, few take slight finger pressure.

48 hours: Mid green. Minor orange patches on bulb. Slight chlorosis on flag. Few leeks softening but generally quite turgid.

72 hours: Mid green. Minor orange discoloration on blanch. Chlorosis with some rots developing on the flags. Softening.
Leeks extended 1.5 cm.

Internal assessments

Out of store: Slight elongation of flower stems, few bolting. Couple with minor internal breakdown.

After 3 days SL: Flower stems elongating, few with flower heads formed, few bolting. Minor internal breakdown.

PORINO: Water colour 138A/B

0 hours: Pale to mid green. Slight orange streaks on shank. Minor chlorosis on outer leaves of flag. Fairly turgid, finger pressure taken.

24 hours: Pale green. Orange streaks on shank. Slight chlorosis on outer flag leaves. Finger pressure taken.

48 hours: Mid green. Orange patches on shank. Chlorosis and some rotting on outer leaves of flag. Some softening.

72 hours: Mid green. Orange patches only. Chlorosis, some minor rots on flags. Softening, some very soft.
Leeks extended 2.7 cm.

Internal assessments

Out of store: Flower stem elongation, half have flower heads formed, couple bolting. No rots.

After 3 days SL: Flower stems thickened and elongating. One third bolting.
Minor internal breakdown.

Removal 1: CA store 31/5/88 (7 weeks)

CORTINA: Control colour 139C

0 hours: Pale mid green. No disease on shanks, minor chlorosis on flags. Quite turgid, few take slight finger pressure.

24 hours: Pale mid green. No disease on shanks. Minor spots of chlorosis on outer leaves of flags. Fairly turgid, slight finger pressure taken.

- 48 hours: Pale mid green, bright. Very little disease. Chlorosis on outer flag leaves. Minor spots of rot developing. Finger pressure taken.
- 72 hours: Pale mid green. Few discoloured around bulb. Chlorosis on flags, some rots developing. Softening.
Leeks extended 0.8 cm.

Internal assessments

Out of store: Flower stems elongating, half only bud stage whilst a few are bolting. No internal breakdown.

After 3 days SL: Flower stems elongating, couple at bud stage and couple bolting. Some internal breakdown present.

CORTINA: Benlate colour 139C

0 hours: Mid green. No disease on shanks or flags. Turgid, few take light finger pressure.

24 hours: Mid green. Few minor orange streaks on shanks. Slight chlorosis on a few flags. Fairly turgid, finger pressure taken.

48 hours: Mid green. Few grey orange discolorations around bulb. Slight chlorosis on outer flag leaves. Some softening, finger pressure taken.

72 hours: Mid green. Slight discoloration around bulb. Chlorosis and some shrivel on outer flag leaves. Few softening, finger pressure taken on most.
Leeks extended 0.8 cm.

Internal assessments

Out of store: Flower stems beginning to elongate. No rots.

After 3 days SL: Flower stems elongating, few have flower heads formed. No internal breakdown.

CORTINA: Water colour 139C

0 hours: Mid green.. No disease on shanks or flags. Quite turgid, few take light finger pressure.

24 hours: Mid green. No disease on shank. Minor spots of chlorosis on a few flags. Fairly turgid, slight finger pressure taken.

48 hours: Pale mid green. Few minor orange streaks on shanks. Minor chlorosis on outer flag leaves. Finger pressure taken, few softening.

72 hours: Pale mid green. Few streaks and discoloured bulbs. Chlorosis and slight shrivel on outer flag leaves. Some softening.
Leeks extended 1.0 cm.

Internal assessments

Out of store: Flower stems beginning to elongate. Couple of minor internal breakdowns.

After 3 days SL: Flower stems beginning to show elongation. No internal breakdown present.

Removal 1: CA store 31/5/88 (7 weeks)

PORINO: Control colour 139 B/C

0 hours: Mid green. No disease on shank or flag. Fairly turgid, few take light finger pressure.

24 hours: Mid green. No disease on shank or flag. Fairly turgid, light finger pressure taken.

48 hours: Mid green. Slight discoloration on few bulb areas. Minor chlorosis and shrivel on outer flag leaves. Finger pressure taken.

72 hours: Mid green. Slight discoloration on bulbs, very small rot. Slight chlorosis on outer flag leaves. Some softening, majority take finger pressure.
Leeks extended 0.7 cm.

Internal assessments

Out of store: Flower stems showing some elongation, third at bud stage, whilst couple bolting. Minor internal breakdown present.

After 3 days SL: Flower stems beginning to elongate. No rots.

PORINO: Benlate colour 139 B/C

0 hours: Mid green. Few minor streaks on shanks. No disease on flags. Fairly turgid.

24 hours: Mid green. Streaks on shanks. Chlorosis on outer flag leaves, few minor rots. Fairly turgid majority, few little soft.

48 hours: Mid green, bright. Discoloration on bulbs, streaks on shanks. Chlorosis and slight shrivel on outer flag leaves, few rots developing. Light finger pressure taken, few soft.

72 hours: Mid green. Discoloration on bulbs, few soft outer flag leaves, rots developing. Softening, majority take finger pressure.
Leeks extended 1.0 cm.

Internal assessments

Out of store: Flower stems showing some elongation, third at bud stage. No internal breakdown.

After 3 days SL: Flower stems showing some elongation, third at bud stage. No rots.

PORINO: Water colour 139C

0 hours: Mid to dark mid green. No disease on shanks or flags. Fairly turgid.

24 hours: Mid to dark mid green. Minor orange streaks on few bulbs. Slight chlorosis on outer flag leaves. Fairly turgid, few take light finger pressure.

48 hours: Mid to darkish mid green. Minor orange discolorations on shanks. Slight chlorosis and some shrivel on outer flag leaves. Some softening.

72 hours: Mid to darkish mid green. Orange grey discolorations on bulbs. Chlorosis on outer flag leaves, some rots. Softening.

Internal assessments

Out of store: Flower stems showing some elongation, third at bud stage. No internal breakdown.

After 3 days SL: Flower stems elongating, flower heads formed on a few. No rots.

Removal 2 Air store 31/5/88 (7 weeks)

CORTINA: Control colour 138B

0 hours: Pale to mid green. No disease on shank. Very minor spots of chlorosis on flag. Fairly turgid, few take slight finger pressure.

24 hours: Pale to mid green. Few orange streaks on shanks. Minor chlorosis on flags. Slight finger pressure taken, few softish.

48 hours: Pale to mid green. Few streaks on shanks. Some discoloration on base of bulb. Flags areas of chlorosis, some rotting on outer leaves. Shivel on edges. Softening.

72 hours: Pale green. Streaks and few minor rots on shanks. Chlorosis of flags. Minor rots on outer leaves, shivel on edges. Softening, some quite soft.
Leeks extended 1.5 cm.

Internal assessments

Out of store: Flower stems elongated, heads formed on a third. Few bolted. Couple of minor internal breakdown.

After 3 days SL: Flower stems elongated and thickening. Flower heads well formed on over half. Some already bolted. No rots.

CORTINA: Benlate colour 138B/C

0 hours: Pale to mid green. No disease on shank or flag. Fairly turgid, few take slight finger pressure.

24 hours: Pale to mid green. No disease on shank or flag. Slight finger pressure taken.

48 hours: Pale mid green. Minor orange spots on bulb. Minor area of chlorosis on few flag leaves. Softening, cell collapse on a few leeks.

72 hours: Pale mid green. Slight discoloration on bulb bases, very minor rot. Some chlorotic patches on outer flag leaves. Softish, quite a few showing cell collapse, being very soft.
Leeks extended 2.4 cm.

Internal assessments

Out of store: Majority showing flower stem elongation, some have flower heads formed, few bolting. Some internal breakdown present.

After 3 days SL: Flower stems elongated and thickening. Flower heads well formed on most. Third bolting. Third had major internal breakdown.

CORTINA: Water colour 138B/C

0 hours: Pale to mid green. No disease on shanks. Minor spots of chlorosis on few flags. Slight finger pressure taken.

24 hours: Pale to mid green. Generally clean shanks. minor chlorosis on outer flag leaves. Losing turgidity, finger pressure taken.

48 hours: Pale to mid green. Grey discoloration on bulbs. Chlorosis and minor shrivel on outer leaves. Softening, some cells collapsing and very soft.

72 hours: Pale mid green. Discoloration at base of bulb. Chlorosis on flag, slight shrivel on edges of leaves. Soft, cells collapsing on quite a few. Leeks extended 2.0 cm.

Internal assessments

Out of store: Flower stems starting to elongate. Some have flower heads developed. Some internal breakdown.

After 3 days SL: Flower stems elongated and thickening, flower heads well developed, over third bolting. Slight internal breakdown.

Removal 2 Air store 31/5/88 (7 weeks)

PORINO: Control colour 138B

0 hours: Mid green. No disease on shanks. Minor spots of chlorosis on outer leaves of flags. Fairly turgid, few take light finger pressure.

24 hours: Mid green. Few orange streaks on shanks. Chlorosis on outer leaves of flag. Slight finger pressure taken, fairly turgid.

48 hours: Mid green. Discoloration on bulb. Chlorosis and slight shrivel on outer flag leaves, minor rots developing. Some softening.

72 hours: Mid green. Discoloration of bulb. Mould growth on a couple of base plates. Chlorosis and rotting on outer flag leaves. Softening, slight cell collapse on a few. Leeks extended 1.6 cm.

Internal assessments

Out of store: Flower stems elongated, some heads formed. Some already bolted. Couple with internal breakdown.

After 3 days SL: Flower stems elongated, couple bolted. No rots.

PORINO: Benlate colour 138 A/B

0 hours: Mid green. No disease on shanks, very minor spots of chlorosis on flags. Fairly turgid few take light finger pressure.

24 hours: Mid green. No disease on shanks. Minor chlorosis on few flags. Fairly turgid.

48 hours: Mid green, fairly bright. Orange discoloration on bulbs. Slight chlorosis and shrivel on outer leaves of flags. Take light finger pressure, some softening.

72 hours: Mid green. Discoloration on bulbs. Chlorosis and shrivel on outer flag leaves, few slight rots developing. Softening. Leeks extended 2.1 cm.

Internal assessments

Out of store: Flower stems elongating, flower heads formed about half. One fifth of leeks at bolting stage. No rotting.

After 3 days SL: Flower stems elongating and thickening. Flower heads forming, half the leeks bolting. Minor internal breakdown present.

PORINO: Water colour 138 A/B

0 hours: Pale to mid green. No disease on shanks. Minor spot of chlorosis on flags. Quite turgid.

24 hours: Pale to mid green. Minor orange discoloration on few bulbs. Chlorosis on outer flag leaves, minor rots developing. Light finger pressure taken.

48 hours: Pale to mid green, brightish. Discolouring on blanch and bulbs. Chlorosis and shrivel on outer flag leaves, rotting developing. Some softening, finger pressure taken.

72 hours: Pale to mid green. Discoloration on bulbs, couple of minor rots on shanks. Chlorosis and shrivelling on outer flag leaves, rotting. Softening.
Leeks extended 1.6 cm.

Internal assessments

Out of store: Flower stems elongating, few flower heads formed. Minor internal breakdown.

After 3 days SL: Flower stems elongating, few heads formed. No rots.

Removal 2 CA store 6/6/88 (8 weeks)

CORTINA: Control colour 138B

0 hours: Pale mid green. No disease on shanks. Slight chlorosis on a few flags. Fairly turgid, some take light finger pressure.

24 hours: Pale to pale mid green. Few minor streaks on shanks. Slight chlorosis on outer flag leaves, few rots developing. Light finger pressure taken, few soft.

48 hours: Pale mid green. Few streaks on shanks. Outer flag leaves shrivelling on edges, slight chlorosis and minor rots. Light finger pressure taken on majority.

72 hours: Pale mid green. Couple minor spots of rot developed. Chlorosis on outer flag leaves, few rots. Quite turgid, finger pressure taken. Leeks extended 0.5 cm.

Internal assessments

Out of store: Flower stems elongating, a fifth showing bolting. No internal breakdown.

After 3 days SL: Flower stems elongated, flower heads formed, half leeks were bolting. Very minor internal rot.

CORTINA: Benlate colour 138 A/B

0 hours: Pale to mid green. Few orange streaks on shanks. Slight chlorosis on a few flags. Fairly turgid.

24 hours: Pale to pale mid green. Few streaks on shanks. Slight chlorosis and shrivel on outer flag leaves. Light finger pressure taken, fairly turgid.

48 hours: Pale to pale mid green. Streaks on shanks. Chlorosis and shrivel on outer flag leaves. Some softening, majority take light finger pressure.

72 hours: Pale mid to mid green. Few minor rots developing on shanks. Chlorosis and shrivel on outer flag leaves. Few softening, light finger pressure taken.
Leeks extended 0.9 cm.

Internal assessments

Out of store: Slight elongation of flower stems, few bolting already. No internal breakdown.

After 3 days SL: Some elongation of flower stems, some flower heads forming. Nearly half were bolting. Very minor internal rot.

CORTINA: Water colour 138B

0 hours: Pale mid green. Few orange streaks on shanks. Slight chlorosis and shrivel on outer flag leaves. Light finger pressure taken, a few softening.

24 hours: Pale to pale mid green. Few streaks on shanks. Chlorosis and slight shrivel on outer flag leaves. Some softening light finger pressure taken.

48 hours: Pale to pale mid green. Streaks on shanks. Chlorosis of outer flag leaves, few minor rots developing. Softening.

72 hours: Pale mid green. Few rots developing on shanks. Outer flag leaves chlorotic, few rots. Softening, few quite soft.
Leeks extended 0.6 cm.

Internal assessments

Out of store: Flower stem elongation, some flower heads formed, fifth at bolting stage. no internal breakdown.

After 3 days SL: Flower stems elongating, few heads formed. Minor internal breakdown.

Removal 2 CA store 6/6/88 (8 weeks)

PORINO: Control colour 138 A/B

0 hours: Mid green. Minor discoloration on few bulbs. Slight shrivel on edges of flags. Quite turgid.

24 hours: Pale mid green. Few minor rots developing. Chlorosis on outer flag leaves. Fairly turgid light finger pressure taken.

- 48 hours: Mid green, few paler. Few rots, discoloration on some bulbs. Chlorosis and shrivel on outer flag leaves. Few softening.
- 72 hours: Mid green. Discoloration on bulbs. Chlorosis on outer flag leaves, minor rots. Some softening, light finger pressure taken, fairly turgid.
Leeks extended 0.4 cm.

Internal assessments

Out of store: Some flower stem elongation, few flower heads formed and bolting.
No internal breakdown.

After 3 days SL: Flower stems elongating, heads formed, some bolting. No internal breakdown.

PORINO: Benlate colour 138A

0 hours: Pale to mid green. Few minor streaks on shanks. Flag leaves fairly clean. Fairly turgid, some take light finger pressure.

24 hours: Mid green, some pale mid green. Few streaks on shanks. Minor chlorosis and shrivel on outer flag leaves. Some softening.

48 hours: Mid green. Discoloration of few bulbs. Slight chlorosis on outer flag leaves. Some softening, finger pressure taken.

72 hours: Mid green. Very little disease, minor discoloration, on shanks. Slight chlorosis on outer flag leaves. Some softening majority fairly turgid, take light finger pressure.
Leeks extended 0.5 cm

Internal assessments

Out of store: Flower stems elongating, flower heads forming, fifth bolting.
No internal breakdown.

After 3 days SL: Flower stems elongated and thickened, heads formed, nearly half bolting. No internal rots.

PORINO: Water colour 138 A/B

0 hours: Mid green, few pale, mid green. No disease on shank. Slight chlorosis and shrivel on flags. Quite turgid.

24 hours: Mid green. Minor discoloration on bulbs. Chlorosis on outer flag leaves. Fairly turgid, few take light finger pressure.

48 hours: Mid green. Discoloured patches on blanch and bulbs. Chlorosis and slight shrivel on outer flag leaves, few rots. Few softening fairly turgid though majority take light finger pressure.

72 hours: Mid green. Discoloration only. Chlorosis and few rots developing on outer flag leaves. Some softening, finger pressure taken.

Internal assessments

Out of store: Flower stems elongation, some flower heads forming, fifth bolting. No internal breakdown.

After 3 days SL: Flower stems elongating. Couple minor internal rots present.

Removal 3 Air store 6/6/88 (8 weeks)

CORTINA: Control colour 138B/144B

0 hours: Pale mid to mid green. Very little disease on shanks. Minor chlorosis and shrivel on outer flag leaves. Fairly turgid, light finger pressure taken.

24 hours: Pale to mid green. Orange streaks and few minor rots on shanks. Chlorosis and shrivel on flags. Some softening.

48 hours: Pale mid green. Rots with mould growth developing, discoloration of blanch and bulbs. Outer flag leaves chlorotic with rots. Leeks softening.

72 hours: Pale mid green. Rots spreading slightly, discoloration of blanch. Chlorotic outer flag leaves, rots increasing. Some shrivel to leaf edges. Leeks quite soft along shoot length. Leeks extended 1.8 cm.

Internal assessments

Out of store: Flower stems elongating, some flower heads formed, one fifth bolting. No internal breakdown.

After 3 days SL: Flower stems thickened and elongated. Flower heads formed over half bolting. No internal breakdown.

CORTINA: Benlate colour 138B

0 hours: Pale mid green. No disease on shanks or flags, though minor shrivel on few leaf edges. Light finger pressure taken.

24 hours: Pale mid green. Few minor rots developing on shanks. Chlorosis and shrivel on outer flag leaves. Slight softening, finger pressure taken.

48 hours: Pale mid green. Areas of rot developing on shanks. Outer flag leaves chlorotic, edges shrivelled. Leeks softening slightly. Majority take finger pressure.

72 hours: Pale mid green. Incidence of rots on shanks increasing, areas mainly minor. Outer flag leaves chlorotic, rots developing. Softening, few quite soft. Leeks extended 1.8 cm.

Internal assessments

Out of store: Flower stems elongating, some flower heads formed, one fifth bolting. No internal breakdown.

After 3 days SL: Flower stems elongating, some thickening and head formed. Half bolting. Some minor internal rots.

CORTINA: Water Colour 138B/144B

0 hours: Pale mid green. Few minor orange streaks on shanks. No disease on flags. Slight shrivel on edges of a few. Fairly turgid, few take light finger pressure.

24 hours: Pale mid green. Few streaks on shank, minor chlorosis and shrivel on outer flag leaves. Slight finger pressure taken.

- 48 hours: Pale to pale mid green. Couple minor rots developed. Chlorosis of outer flag leaves. Softening.
- 72 hours: Pale green. Couple of rots, some discoloration of blanch. Chlorotic outer flag leaves, edges shrivelled, few rots developing. Softening, some cell collapse. Leeks extended 1.4 cm.

Internal assessments

- Out of store: Flower stems elongating, some flower heads formed. Nearly a third are bolting. No internal breakdown.
- After 3 days SL: Flower stems thickened and elongated. Flower head formed, nearly half bolting. Very minor internal rot.

Removal 3 Air store 6/6/88 (8 weeks)

PORINO: Control Colour 138 A/B

- 0 hours: Mid green, some paler. No disease on shanks. Slight chlorosis and shrivel on outer flag leaves. Fairly turgid, few take light finger pressure.
- 24 hours: Mid green. Orange streaks and discoloration of blanch. Chlorosis and shrivel on outer flag leaves. Fairly turgid, light finger pressure taken.
- 48 hours: Mid green. Streaks on shanks, quite a lot of discoloration of blanch. Outer flag leaves chlorotic, few minor rots. Some softening, majority take finger pressure.
- 72 hours: Mid green. Few rots developing, discoloration of blanch. Chlorosis and shrivel of outer flag leaves, few minor rots. Leeks softening.

Internal assessments

- Out of store: Some flower stem elongation, one fifth bolting. No internal breakdown.
- After 3 days SL: Flower stems elongated, heads formed, couple bolting. No internal breakdown.

PORINO: Benlate Colour 138 A/B

- 0 hours: Mid green. Very little disease on shanks or flags. Some slight shrivel on leaf edges. Fairly turgid, few take light finger pressure.
- 24 hours: Pale mid to mid green. Some slight discoloration on the bulbs. Slight chlorosis and shrivel on outer flag leaves, few minor rots. Fairly turgid, light finger pressure taken.
- 48 hours: Pale mid green. Discoloration of blanch. Chlorosis of outer flag leaves, few rots developing. Few softening, finger pressure taken on majority.
- 72 hours: Pale mid to mid green. Couple of minor rots, discoloration of blanch. Outer flag leaves chlorotic edges shrivelling, few rots developing. Leeks softening, few quite soft. Leeks extended 1.6 cm.

Internal assessments

Out of store: Flower stems elongating, some thickening with heads formed, a third bolting. No internal breakdown.

After 3 days SL: Flower stems thickened and elongated, heads forming, a third bolting. Few minor internal rots.

PORINO: Water colour 138 A/B

0 hours: Pale to mid green. Few minor discoloured patches around bulb. Slight chlorosis and shrivel on outer flag leaves. Fairly turgid some take light finger pressure.

24 hours: Pale to mid green. Minor streaks on shanks and discoloured areas on blanch. Chlorosis on outer flag leaves, few rots developing. Finger pressure taken.

48 hours: Pale mid to mid green. Orange streaks and discoloration only. Chlorosis on outer flag leaves, slight shrivel of edges. Minor rotting. Some softening.

72 hours: Pale mid to mid green. Few rots developing, quite a few discoloured areas on blanch. Outer flag leaves chlorotic, with shrivel and rots on some. Softening, majority take finger pressure.

Internal assessments

Out of store: Flower stems elongating, some flower heads formed. One sixth bolting. No internal breakdown.

After 3 days SL: Flower stems thickened and over half way up length. Half were bolting. No internal breakdown.

Removal 3 CA store 13/6/88 (9 weeks)

CORTINA: Control colour 138B

0 hours: Mid green. No disease on shanks, slight chlorosis on outer flag leaves. Some softening, light finger pressure taken.

24 hours: Pale mid to mid green. Minor discoloration on few bulbs. Slight chlorosis and shrivel on leaf edges of flags. Some softening, finger pressure taken.

48 hours: Pale mid to mid green. Greyish discoloration of few blanch areas. Slight chlorosis and shrivel on outer flag leaves. Few softening, finger pressure.

72 hours: Pale mid to mid green. Few blanch areas discoloured. Chlorosis of outer flag leaves. Softening, quite a few fairly soft. Leeks extended 1.3 cm.

Internal assessments

Out of store: Flower stems elongating, some heads formed. A third were bolting. No internal breakdown.

After 3 days SL: Flower stems elongating, few bolting. No internal breakdown.

CORTINA Benlate colour 138B/144B
0 hours: Pale mid green. Few minor orange streaks. Slight chlorosis on a few flag leaves. Fairly turgid, light finger pressure taken.
24 hours: Pale mid green. Few streaks on shanks. Slight chlorosis and shrivel on leaf edges. Finger pressure taken by most.
48 hours: Pale mid green. Some streaks, few minor rots. Chlorosis on outer flag leaves. Few softening, finger pressure taken.
72 hours: Pale mid to mid green. Few rots developing. Outer flag leaves chlorosis and some minor rots. Slight softening, majority take finger pressure.
Leeks extended 0.8 cm.

Internal assessments

Out of store: Elongating of flower stems, some heads formed. Third bolting.
No internal breakdown.

After 3 days SL: Flower stems elongating, some thickening and heads formed.
Third bolting. Very minor internal rot.

CORTINA: Water colour 138B/144B

0 hours: Mid green. Numerous orange streaks on shanks. Slight chlorosis on outer flag leaves. Some softish, finger pressure taken.
24 hours: Pale mid to mid green. Streaks, some softening. Chlorosis on outer flag leaves. Softening.
48 hours: Pale mid to mid green. Few of streaks deteriorated, slight greyish discoloration of blanch and bulbs. Chlorosis on outer flag leaves, few rots developing. Softening, finger pressure taken.
72 hours: Pale mid to mid green. Streaks and rots, discoloration of blanch. Outer flag leaves chlorotic, some quite deteriorated. Soft, some cell collapse.
Leeks extended 1.7 cm.

Internal assessments

Out of store: Flower stems elongation taking place, few heads formed, a fifth bolting. Some internal rots present.

After 3 days SL: Flower stems elongating, few heads formed, slight bolting.
No internal breakdown present in this sample.

Removal 3 CA store 13/6/88 (9 weeks)

PORINO: Control colour 138 A/B

0 hours: Mid green. No major disease. Slight chlorosis of outer flag leaves. Turgid, few take light finger pressure.
24 hours: Mid green. Few minor rots developing. Chlorosis and slight shrivel on outer leaves. Fairly turgid, finger pressure taken.

48 hours: Mid green. Rots developing, few badly. Some discoloration of blanch and bulbs. Outer flag leaves chlorotic, some rots developing. Finger pressure taken.

72 hours: Mid green to dark mid green. Areas of rot on shanks. Outer flag leaves chlorosis and rots developing. Some softening of leeks. Leeks extended 1.1 cm

Internal assessments

Out of store: Slight elongation of flower stems, very few heads forming. No internal breakdown.

After 3 days SL: Flower stems elongating, heads formed, nearly half bolting. No internal breakdown.

PORINO: Benlate 138A

0 hours: Pale to pale mid green. No disease, slight chlorosis only on outer flag leaves. Fairly turgid.

24 hours: Pale mid to mid green. No disease, slight chlorosis and shrivel on outer flag leaves. Light finger pressure taken.

48 hours: Mid green. Slight discoloration of blanch, few minor spots of rot. Chlorosis on outer flag leaves. Some softening.

72 hours: Mid green. Blanch greyish discoloration, few rots developing. Chlorosis and shrivel on outer flag leaves. Some softening but still fairly turgid. Leeks extended 0.6 cm.

Internal assessments

Out of store: Some elongation of flower stems, few heads forming, third bolting. Slight internal breakdown present.

After 3 days SL: Some elongation of flower stems, heads forming, third bolting. No internal breakdown in this sample.

PORINO: Water colour 138 A/B

0 hours: Mid green. No disease on shanks. Chlorosis and slight shrivel on outer flag leaves. Turgid.

24 hours: Mid green. Some slight discoloration of blanch. Chlorosis on outer flag leaves. Light finger pressure taken, few softening.

48 hours: Mid green. Blanch discoloration, few rots developing. Outer flag leaves chlorosis and minor rots. Beginning to soften.

72 hours: Mid green. Blanch discoloration, few rots. Chlorosis and rots on outer flag leaves. Quite a few were soft of softening. Leeks extended 0.9 cm.

Internal assessments

Out of store: Some elongation of flower stems, few heads forming, less than a third bolting. No internal breakdown.

After 3 days SL: Some elongation of flower stems, couple with headd forming and bolting. No internal breakdown.

Removal 4 Air store 13/6/88 (9 weeks)

CORTINA: Control colour 138B/144B

0 hours: Pale mid green. No disease on shanks. Slight chlorosis on some outer flag leaves, generally quite clean. Some leeks softish, finger pressure taken.

24 hours: Pale mid green. Few orange streaks on shanks. Chlorosis and slight shrivel on outer flag leaves, some rots developing. Softening.

48 hours: Pale mid green. Streaks and few minor rots on shanks. Chlorosis and slight shrivel on outer flag leaves, rots have mould growth. Fairly soft.

72 hours: Pale to pale mid green. Few rots, discoloration on blanch. Chlorotic, shrivelling flag leaves, rots increasing, some had mould growth. Soft, some cell collapse. Leeks extended 0.9 cm.

Internal assessments

Out of store: Flower stems thickening and elongating, some heads formed. Just over a third bolting. No internal breakdown.

After 3 days SL: Flower stems thickened and elongating, heads formed, a third were bolting. Minor internal rot.

CORTINA: Benlate colour 138B/144B

0 hours: Pale to pale mid green. minor greyish discoloration around bulb. Slight chlorosis on outer flag leaves. Fairly turgid, some light finger pressure taken.

24 hours: Pale to pale mid green. Some discoloration around bulbs. Slight chlorosis and shrivel on leaf edges of flags. Some softening, finger pressure taken.

48 hours: Pale mid green. Discoloration on some bulbs and blanch. Chlorosis and shrivel on outer flag leaves. Softening.

72 hours: Pale mid green. Greyish discoloration, few minor rots. Chlorosis and shrivel on outer flag leaves. Some leeks quite soft, some have cell collapse. Leeks extended 2.3 cm.

Internal assessments

Out of store: Flower stems elongating, few heads forming, fifth were bolting. No internal breakdown.

After 3 days SL: Flower stems thickened and elongated, heads formed on majority, half bolting. No internal breakdown.

CORTINA Water colour 144B/138B

0 hours: Pale to pale mid green. Minor orange streaks on shanks. Slight chlorosis and few minor rots on outer flag leaves. Some leeks softish, finger pressure taken.

24 hours: Pale to pale mid green. Some rots developing on shanks, some blanch discoloration. Outer flag leaves becoming chlorotic with rots and mould growth developing. Fairly soft.

48 hours: Pale to pale mid green. Rots developing on shanks, discoloration of blanch. Flag leaves chlorotic, rots developing. Some mould growth. Majority fairly soft, few leeks showing cell collapse.

72 hours: Pale to pale mid green. Deterioration of leeks, numerous rots. Blanch greyish discoloration. Flag leaves chlorotic with quite a few rots. Some mould growth around tops. Very soft, many cell collapse.
Leeks extended 2.7 cm.

Internal assessments

Out of store: Some flower stem elongation, some heads formed. Third bolting. Couple minor internal rots.

After 3 days SL: Flower stems elongated, some heads formed. Third bolting. Very minor internal rot.

Removal 4 Air store 13/6/88 (9 weeks)

PORINO: Control colour 138B/144B

0 hours: Mid green. Few minor orange streaks on shanks. Slight chlorosis on outer flag leaves. Quite turgid.

24 hours: Pale mid green. Greyish yellow discoloration of few blanch areas. Slight chlorosis on outer flag leaves, some small areas of rot. Fairly turgid, some take light finger pressure.

48 hours: Pale mid green. Some yellowish discoloration of blanch, few minor rots. Chlorosis on outer flag leaves, rots developing, some mould growth. Finger pressure taken some still quite turgid.

72 hours: Pale mid to mid green. Some minor areas of rot, blanch discoloring. Flag leaves chlorotic with numerous rots developing some mould growth. Softening.
Leeks extended 1.8 cm

Internal assessments

Out of store: Flower stems elongating, some thickening and flower heads formed. Third at bolter stage. Some minor internal rots.

After 3 days SL: Flower stems elongating, flower heads forming, half bolting. No internal breakdown present.

PORINO: Benlate colour 138 A/B

0 hours: Pale to mid green. No disease on shanks. Slight chlorosis on outer flag leaves. Fairly turgid.

24 hours: Pale mid to mid green. Slight discoloration on some bulbs. Slight chlorosis and minor rots on flag leaves. Light finger pressure taken.

- 48 hours: Pale mid to mid green. Discoloration on blanch and bulb. Outer flag leaves chlorotic, slight shrivel, few small rots. Some softening.
- 72 hours: Pale mid to mid green. Discoloration, few minor rots. Flag leaves chlorotic, some rotting on outer leaves. Some quite soft with cell collapse, majority soft.
Leeks extended 2.2 cm.

Internal assessments

Out of store: Flower stems elongating, some heads formed, few already bolting.
No internal breakdown.

After 3 days SL: Flower stems elongated, some thickening and heads formed.
Third bolting. No internal breakdown.

PORINO: Water colour 138B

- 0 hours: Mid green. Some areas of rot present on shanks. Flag leaves chlorotic, few rots on outer leaves. Fairly turgid, light finger pressure taken.
- 24 hours: Pale mid green. Rapid deterioration of areas of rot on shanks. Outer flag leaves chlorotic and shrivelling, some rots developing. Fairly turgid, some softening.
- 48 hours: Pale mid green. Numerous rots blanch areas discoloured. Outer flag leaves chlorotic, rots developing on outer leaves. Some softening, finger pressure taken.
- 72 hours: Pale mid green. Sample badly rotting, discoloration of blanch areas. Chlorotic flag leaves, some shrivel on edges. Rotting increasing. Softening, some quite soft.
Leeks extended 2.5 cm.

Internal assessments

Out of store: Elongation of flower stems in majority of leeks, some flower heads formed. Third bolting. Couple with internal rots.

After 3 days SL: Some fully elongated and heads well formed, some flower stems elongating. Half bolting. No internal rots.

Removal 4 CA store 21/6/88 (10 weeks)

CORTINA: Control colour 138B/144A

- 0 hours: Palish mid green. No disease, minor discoloration on few bulbs. Slight chlorosis on outer flag leaves. Some softness, finger pressure taken.
- 24 hours: Pale mid green. Few orange streaks on shanks and minor rots. Chlorosis on outer flag leaves, shrivel on edges, few rots developing. Softening.
- 48 hours: Pale mid to mid green. Streaks and rots developing. Outer flag leaves chlorosis and shrivelled edges, some rotting. Fairly soft.
- 72 hours: Pale mid to mid green. Quite a few small areas of rot developing on shanks. Discoloration of blanch. Chlorosis and rotting on outer flag leaves. Quite soft.
Leeks extended 1.2 cm.

Internal assessments

Out of store: Some elongation of flower stems, few bolting. Couple with internal rots.

After 3 days SL: Elongation of flower stems, heads forming, few bolting. No internal breakdown in this sample.

CORTINA: Benlate colour 138B

0 hours: Mid green, some paler. Few minor rots and discoloration of blanch. Slight chlorosis on some flag leaves. Fairly turgid.

24 hours: Mid green, some pale mid green. No deterioration of disease. Slight chlorosis on some outer flag leaves. Light finger pressure taken.

48 hours: Mid-dark mid green. No deterioration of disease, slight discoloration of blanch. Slight chlorosis and shrivel of outer flag leaves. Fairly turgid, little softening.

72 hours: Mid to dark mid green. Minor rots, discoloration of blanch. Outer leaves chlorotic, few minor rots developing. Leeks beginning to soften. Leeks extended 1.5 cm.

Internal assessments

Out of store Slight elongation of flower stems, few bolting. Minor internal breakdown.

After 3 days SL: Elongation of flower stems, heads forming, few bolting. No internal breakdown.

CORTINA: Water colour 138B/144A

0 hours: Mid green. Minor streaks and discoloration of blanch. Slight chlorosis on outer flag leaves. Light finger pressure taken.

24 hours: Mid green. Few small rots developing. Some chlorosis on outer flag leaves. Slight softening.

48 hours: Mid green. Rots developing on shanks. Outer flag leaves chlorotic with few minor rots. Softening.

72 hours: Mid green. Rots deteriorating, some areas badly infected, discoloration of blanch. Chlorosis, minor rots on outer flag leaves. Softish, a few quite soft. Leeks extended 1.4 cm.

Internal assessments

Out of store: Some elongation of flower stems, few bolting. Minor interior breakdown.

After 3 days SL: Flower stems elongating, heads forming, few bolting. No internal breakdown.

Removal 4 CA store 21/6/88 (10 weeks)

PORINO: Control colour 138 A/B

0 hours: Pale mid green. No disease, slight grey discoloration of blanch. Slight chlorosis of outer flag leaves. Fairly turgid, finger pressure taken.

24 hours: Mid green, some paler. Few minor rots developing. Slight chlorosis, minor shrivel on outer flag leaves some minor rots. Finger pressure taken.

48 hours: Mid green. Rots not deteriorating, blanch discolouring. Outer flag leaves chlorosis, few minor rots. Slight softening.

72 hours: Mid green. Few more minor rots developed, blanch some discoloration. Outer flag leaves chlorotic, rots developing. Softening, some still fairly turgid. Leeks extended 0.8 cm.

Internal assessments

Out of store: Some elongation of flower stems, few bolting. No internal breakdown.

After 3 days SL: Flower stems elongating, heads forming. A third were bolting. No internal breakdown.

PORINO: Benlate colour 138 A/B

0 hours: Mid to darkish green. No disease on shanks. Minor chlorosis on flags. Fairly turgid.

24 hours: Mid to darkish green. No disease on shanks. Minor chlorosis and shrivel on outer flag leaves. Light finger pressure taken by some.

48 hours: Mid to dark mid green. Slight discoloration of blanch. Chlorosis and shrivel on outer flag leaves. Few softening slightly.

72 hours: Dark mid green. Few very minor spots of rotm blanch discolouring. Chlorosis of outer flag leaves. Softening few quite soft. Leeks extended 1.5 cm.

Internal assessments

Out of store: Some elongation of flower stems, few heads forming, fifth bolting. No internal breakdown.

After 3 days SL: Flower stems elongating, few heads forming, some bolting. No internal breakdown.

PORINO: Water colour 138A

0 hours: Mid green. No disease on shanks. Slight chlorosis on the outer leaves. Fairly turgid.

24 hours: Mid green. Minor discoloration of blanch. Slight chlorosis and shrivel on outer flag leaves. Light finger pressure taken.

48 hours: Darkish mid green. Minor discoloration on blanch. Chlorosis and shrivel on outer flag leaves. Slight softening, majority take finger pressure.

72 hours: Mid to dark mid green. Few rots developing, blanch areas discoloured. Outer flag leaves chlorosis and some minor rotting. Some softening.
Leeks extended 1.1 cm.

Internal assessments

Out of store: Slight elongation of flower stems, few bolting, some slight internal rotting.

After 3 days SL: Some elongation of flower stems. Few heads forming, few bolting. No internal breakdown in this sample.