

HORTICULTURE RESEARCH INTERNATIONAL

EFFORD

Report to: Horticultural Development Council
18 Lavant Street
PETERSFIELD
Hampshire
GU32 3EW

Tel: 01730 263736

Fax: 01730 265394

HRI Contract Manager: Dr D J Hand
HRI Efford
LYMINGTON
Hampshire
SO41 0LZ

Tel: 01590 673341

Fax: 01590 671553

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CONTRACT REPORT

**Poinsettia: The response of a
range of cultivars to cultural and chemical
treatments with a view to improving shelf-life**

**HDC PC71a
1993/94**

PRINCIPAL WORKERS

HRI EFFORD

Dr D J Hand BSc Hons, PhD, M.I. Hort, MRPPA	Head of Protected Crops (Author of Report)
Mr L P H Sach BSc Hons (Hort), M.I. Hort, MRPPA	Technical Officer (until 30.10.93)
Mrs E J Hemming BSc Hons (Hort), M.I. Hort	Scientific Officer
Miss S Horsley	Assistant Scientific Officer
Mr C Vigor	Nursery Staff
Mr C A J Hemming	Nursery Staff
Miss A Peek BSc	Nursery Staff
Mr S Langford	Nursery Staff
Mr P Burnell	Nursery Staff

HRI LITTLEHAMPTON

Dr F A Langton BSc Hons, PhD, FI Hort	Plant Physiologist
Mr R N Edmonson MSc	Statistician

ADAS

Mr H Kitchener BSc	Senior Consultant
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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.

Signature

Margaret A. Scott
.....

Miss M A Scott
Science Co-ordinator

Date *10/5/96*
.....

Report authorised by

MRS
.....
Signature

Dr M R Shipway
Head of Station

HRI Efford
LYMINGTON
Hants
SO41 0LZ

Date *10.5.96*
.....

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HDC PC71a

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**Dr D J Hand
Mr L P H Sach
HRI Efford**

**Dr F A Langton
HRI Littlehampton**

**H Kitchener
ADAS**

HDC Co-ordinator: Mr H Gimmler

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1. RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

1.1 APPLICATION

Previous work (PC 71) has shown that many new Poinsettia cultivars have short response times and thus colour too early for the traditional UK Christmas market. In this trial the use of night break lighting (NBL) was further evaluated as a means of delaying floral induction. In addition, the effect of humidity during production and the application of calcium chloride sprays near to marketing were evaluated in respect to the prevention of bract edge necrosis.

Lilo was the fastest cultivar to show development of cyathia, flower induction occurring between 5-19 September, whilst Freedom was slightly slower to show cyathia but reached marketing stage much earlier. Red Sails was slower to show cyathia (induction 16-19 September). Weather conditions around the equinox, 22/23 September, will affect flowering; dull weather will advance flowering whilst bright conditions will delay flowering.

The use of NBL delays floral induction and can be used successfully to improve crop scheduling. Delayed floral induction will increase the average leaf number and hence plant height is often increased under NBL regime.

The effects of humidity treatments during production and the application of calcium chloride from bract colouring had little impact on the incidence of bract edge necrosis, one of the primary objectives of the trial. However, the removal of sleeves prior to entering shelf-life may have acted to reduce the incidence of this disorder.

1.2 SUMMARY

This project was commissioned to assess new and existing Poinsettia cultivars for production in the UK for marketing in December with regard to initiation date, bract quality, flower development and shelf-life. Simulation of high humidities, a factor commonly associated with bract blackening, was also considered, including potential remedial spraying of calcium chloride to avoid bract blackening.

Treatments

Initiation and humidification regimes

- A. Natural season (N/S) initiation with ambient humidity (plants grown on ebb and flood floors).

- B. Initiation delayed by 10 days with night break lighting (NBL) of four hours from pinching, ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with NBL as B above, ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% RH from bract colouring (plants grown on ebb and flood floors).
- E. Natural season initiation, ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% RH from bract colouring (plants grown on benches).

A total of six cultivars were studied within the main trial:

Eckespoint	-	Red Sails	Selecta Klemm	-	Fireking
Eckespoint	-	Freedom	Gutbier's	-	Ria
Eckespoint	-	Lilo	Jacobsen's	-	Peterstar

The cultivars Francesca, Glenda and Menorca were also included in dissection studies undertaken at HRI Littlehampton.

Pre shelf-life treatments

In an attempt to reduce the incidence of bract blackening, Calcium Chloride at a rate of 400 mg/litre was applied from bract colouring to marketing. This treatment was confined to the natural season crop both with and without humidification (treatments A, D, E and F), and applied at the following intervals:

1. Untreated control
2. Weekly
3. Fortnightly
4. Single spray just prior to marketing.

Results

Using N/S production techniques Lilo, consistent with 1992 (PC 71) was the fastest cultivar to show development of cyathia closely followed by the cultivars Freedom and Glenda. However, this need not necessarily reflect the speed of floral induction since cultivars differ in their speed of floral development once induced.

Where plants were NBL until 2 October all plants can be assumed to have initiated at the same date. The fact that Lilo was again the most advanced confirms that it does indeed possess very rapid floral development. The cultivar Glenda was similarly fast.

Dates of induction could be calculated for NBL crops since all crops could be assessed at the same point. These dates could then be used to back calculate and determine the point of induction of the cultivars under N/S conditions.

Freedom has consistently been shown to be an early cultivar for marketing purposes, but it is not faster to flower than Lilo. Lilo is the earliest cultivar with flower induction occurring between 5-19 September (17/9 in 1992). In contrast, Red Sails is slow to show flowers but does induce them early (16-19/9), this was five days earlier than the preceding study (PC 71) and probably indicates natural variation from year to year for N/S flowering. Bright conditions around the equinox will delay flowering, dull conditions will advance flowering.

Delayed floral induction by the use of NBL increased the average leaf number below the cyathium by three when comparing N/S with NBL for 10 days and five when comparing N/S with NBL for 20 days. Differences in leaf number were reflected in different plant heights at marketing, those receiving NBL being taller.

The effects of humidity treatments during production and the application of calcium chloride from bract colouring had little impact on the incidence of bract edge necrosis, one of the primary objectives of the trial. However, the removal of sleeves prior to entering shelf-life may have acted to reduce the incidence of this disorder.

1.3 CONCLUSIONS

- NBL for either 10 or 20 days, subject to cultivar, was again shown to be an effective means of manipulating floral induction and hence scheduling cultivars for the Christmas market.
- Apical dissection enabled the point of initiation of cultivars to be accurately determined.
- The use of night break lighting had a tendency to increase plant height and spread. The latter could be attributed to a greater number of leaves below the cyathium where initiation had been delayed by NBL.
- Positive humidification of the crop during production had no consistent effect on the incidence of bract edge necrosis.
- Consequently the application of calcium chloride prior to marketing confirmed no benefit in terms of reducing this disorder.

2. EXPERIMENTAL SECTION

2.1 INTRODUCTION

The new Poinsettia cultivars generally have a shorter response time from initiation to development of the bract and flower, for example 7.5 weeks for Freedom as opposed to 9 weeks for Angelika. While this does not affect the main European market, where crops are required for mid November, in the UK the traditional Poinsettia sales period is mid December. The increased period of storage prior to harvest under day neutral conditions has led to production problems such as bract blackening (calcium deficiency of the bract) and cyathia drop. Delayed initiation by using night break lighting (NBL) can help to allow scheduling of crops for later markets (December) as shown in the 1992 trial at HRI Efford. However, high humidity can increase the possibility of bract blackening and American trials have indicated that calcium chloride sprays and/or humidity control reduces this problem.

The shelf-life of UK produced Poinsettias is a selling point for this crop and any damage to bracts or reduction in shoot number detracts from market price. Improving plant quality at harvest by the use of techniques such as NBL and DIF, reducing the risk of bract damage and cyathia loss, together with assessing new cultivars is necessary for the continued success of this product in the UK market place. 1992 was a particularly bad year for bract blackening and although it is not easy to assess the likely losses due to poor quality or bract damage a figure of losses per year is estimated notionally at between £150 - 175K.

This project was commissioned to assess new and existing Poinsettia cultivars for production in the UK for marketing in December with regard to initiation date, bract quality, flower development and shelf-life. Simulation of high humidities, a factor commonly associated with bract blackening, was also considered, including potential remedial spraying of calcium chloride to avoid bract blackening.

2.2 OBJECTIVES

- To evaluate the effect of night break lighting (NBL) on the floral induction of Poinsettia compared to natural season (N/S) induction.
- To quantify the effects of differing humidity regimes on the incidence of the disorder bract edge necrosis.
- To establish the benefits of applications of calcium chloride weekly, fortnightly or once prior to marketing on the incidence and severity of bract edge necrosis during shelf-life.

2.3 MATERIALS AND METHODS

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2.3.1 Site

The plants were grown on benches or ebb and flood floors in six compartments of the multifactorial glasshouse unit 'K' block.

2.3.2 Cultivars

Plants for the trial were purchased from Hollyacre Plants Ltd as rooted cuttings which were delivered and potted in week 33 (w/c 16 August 1993). Full crop diaries can be found in Appendix I, pages 25 to 32.

A total of six cultivars were studied within the main trial:

Eckespoint	Red Sails
Eckespoint	Freedom
Eckespoint	Lilo
Selecta Klemm	Fireking
Gutbier's	Ria
Jacobsen's	Peterstar

The cultivars Francesca, Glenda and Menorca were also included in the dissection studies undertaken at HRI Littlehampton.

2.3.3 Treatments

Initiation and humidification regimes

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) of four hours from pinching, ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with NBL as B above, ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% RH from bract colouring (plants grown on ebb and flood floors).

- E. Natural season initiation, ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% RH from bract colouring (plants grown on benches).

Pre shelf-life treatments

In an attempt to reduce the incidence of bract blackening, Calcium Chloride at a rate of 400 mg/litre was applied from bract colouring to marketing. This treatment was confined to the natural season crop both with and without humidification (treatments A, D, E and F), and applied at the following intervals:

1. Untreated control
2. Weekly
3. Fortnightly
4. Single spray just prior to marketing.

2.3.4 Experimental design

The trial was laid out following an unreplicated split plot design.

4	main plots (humidity x lighting)
x	
6	sub plots (varieties)

24	sub plots in total

Each experimental plot initially comprised 60 plants when plot thick. The trial layout is given in Appendix II, page 33.

2.3.5 Cultural Details

On arrival the plants were inspected by the Plant Health and Seed Inspectorate and found to be free of *Bemisia*.

Rooted cuttings were potted into 13 cm AX terracotta pots using Fison's Levington C2 on 16.8.93. Plants were covered with Agryl for the first week post potting. Daily damping of the floors was undertaken to increase the humidity of individual compartments.

Shortly after potting on 23 August furalaxyl (as Fongarid 25 WP) was applied as a drench to control *Phytophthora* and *Pythium sp.* An application of the parasitic nematode *Steinernema feltiae* (as Nemasys) was made for the control of sciarid fly (*Lycorella sp.*). The former was applied at a rate of 1 bag in 100 litres of water per 2000 plants. A further fungicide treatment using etridiazole (as Aaterra) at a rate of 5 g/m² in 10 litres of water was made on 31 August 1993.

The variety Fireking was pinched back to 5 leaves on 24.8.93; the remainder, with the exception of Francesca, to six leaves; Francesca was pinched back to six leaves two days later on 26.8.93. After pinching the plants were again covered with Agryl for a few days to raise ambient humidity levels.

Spacing: A first spacing to 17 cm was made on 9.9.93. The variety Fireking was spaced to 20 cm on 1.10.93; the remaining varieties were spaced to 22 cm ten days later on 11.10.93. A final spacing to 30 cm was undertaken for all varieties on 14.10.93.

Temperature: The temperature the plants were grown at was adjusted according to crop growth stage in each compartment. Plants were established at 21 °C with bract initiation at 19 °C. As marketing approached temperature set points were lowered gradually to a 'finishing' temperature of 14 °C (Table 1).

Table 1: Approximate dates for temperature regimes during growth

	Natural Season	NBL to 2 October	NBL to 12 October
DROP start	01.09.93	01.09.93	01.09.93
DROP stop	22.09.93	02.10.93	12.10.93
Temp. drop to 19 °C	22.09.93	02.10.93	12.10.93
Start of drop to 14 °C	19.11.93	30.11.93	07.12.93

A full crop diary for each compartment can be found in Appendix I pages 25 to 32.

Growth Regulation: A DROP regime of 4 °C for 2 hours at sunrise was applied across all compartments as a standard cultural technique. The DROP regime commenced from pinching and was continued until bract initiation. The DROP regime was therefore longer where initiation was delayed with NBL for 10 or 20 days.

Growth regulation via chemical means was achieved using Cycocel (chlormequat 46%) typically at 1 ml/litre + 0.5 ml/litre spreader. Full details of the timing and rates can be found in the crop diary, Appendix I, pages 25 to 32.

Nutrition

Liquid feeding commenced at every watering once the first breaks became visible. The initial feed composition supplied was 250 ppm N, 60 ppm P₂O₅ and 150 ppm K₂O plus 0.1 ppm Mo. From the end of October this was altered to give 200 ppm N, 50 ppm P₂O₅, 200 ppm K₂O plus 0.1 ppm Mo (table 2).

Table 2: Stock feed composition

Material	Initial g/l	Final g/l
Mono ammonium phosphate	20	17
Potassium nitrate	66	87
Ammonium nitrate	113	76
Ammonium molybdate	0.05	0.05
Librel Fe lo	0.2	0.2

Diluted 1 in 200

Night break lighting

Night break lighting (NBL) was given for four hours each night from 2200 hrs to 0200 hrs. The 60W GLS tungsten bulbs gave a light level of 200-250 lux at crop height.

Shelf-life

Immediately prior to being placed in a controlled shelf-life environment plants underwent simulated marketing. Six plants from each plot were sleeved, boxed and despatched on a market run. On their return the sleeves were removed and the plants were placed in shelf-life conditions of 20°C and 1000 lux for a 12 hour day. Plants were then assessed over a six week period.

2.3.6 Assessments

Apical dissections

Samples, each comprising five plants, were sent to HRI Littlehampton for apical dissection to determine the time of initiation.

The following cultivars were examined:

Cultivar	Code
Francesca	A
Freedom	B
Fireking	C
Glenda	D
Lilo	E
Menorca	F
Red Sails	G
Ria	H

from each of the following treatments; Natural season flowering, night break lighting until 2 October (NBL 2/10) and night break lighting to 12 October (NBL 12/10).

The dates on which plants were sampled are summarised below in table 3.

Table 3 Sampling dates for apical dissection

Treatment	Dates
N/S	21/9, 28/9, 5/10, 12/10, 16/10
NBL 2/10	12/10, 19/10, 25/10, 2/11 (F, G, H only)
NBL 12/10	25/10, 2/11, 9/11 (C, F, G, H only)

In each case the break from the axil of the penultimate leaf on the pinched main stem was chosen for dissection. The flowering stages were as used in 1992 (PC71) and are defined in Appendix III, page 34.

At Marketing

At the point of marketing, when the bracts were well coloured, full assessments were made. These included:

- Plant height (mm)
- Plant spread at widest point (mm)
- Plant spread at 90° to widest point (mm)
- Number of bracts (heads) forming upper canopy of plant
- Bract (head) diameter (mm)
 - > 225
 - > 200
 - > 150
 - < 150
- Quality

Criteria for quality grading are defined in Appendix IV, page 35.

Shelf-life

Only plants from the natural season crops, treatments A, D, E and F went forward for shelf-life assessment.

Six plants from each plot were sleeved, boxed and dispatched on a transport run. On their return the sleeves were removed and plants placed into shelf-life conditions of 20°C and 1000 lux for a 12 hour day.

Over the next six weeks plants were monitored for:

Bract damage

- Necrosis
- Rabbit tracking
- Other

Leaf damage

- Blueing
- Drop
- Yellowing

Cyathia presence or absence

2.3.7 Statistical Analysis

For the marketing assessments, results were subject to Analysis of Variance (ANOVA) in order to assign statistical significance to treatment effects. Shelf-life data were not subject to full analysis owing to the lack of replicates. These data should therefore be interpreted with caution.

2.4 MATERIALS AND METHODS

B. COMMERCIAL TRIALLING

2.4.1 Sites

Plants were grown on two commercial holdings:

- a. Helmut Gimmler Ltd, Gore Road, New Milton, Hants
- b. H Evans Ltd, Europa Nursery, Hadlow, Kent

2.4.2 Cultivars

The twelve cultivars grown in the main trial were further evaluated on both commercial holdings.

2.4.3 Cultural Details

Rooted cuttings for the commercial nurseries were purchased from Hollyacre and Selecta Klemm for sites a and b respectively and potted in weeks 33 and 34 into 13 cm pots.

All plants were pinched 7 to 10 days after potting. In all other respects crop culture followed best local practice.

2.4.4 Assessments

Plants were recorded at the two sites on 22 November and 9 December respectively. In addition to notes on the individual varieties, plant height, width, the number of bract heads and their diameter were recorded.

2.4.5 Statistical Analysis

Observations on commercial holdings were not replicated and therefore data could not be subject to formal statistical analysis.

3. RESULTS

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3.1 Apical dissections - HRI Littlehampton

3.1.1 Rates of apical development

The rates of apical development as a function of both lighting treatments and cultivar are summarised in figures 1 to 3, page 16.

As would have been expected the order of appearance of visible cyathia was N/S, followed by NBL 2/10 and then NBL 12/10.

Natural Season: Lilo was the fastest to show cyathia development (as in 1992), closely followed by Freedom and Glenda. The others were slower and similar. However, this may not necessarily reflect the order of flower induction, since cultivars differ in their speed of flower development once flowers have been induced.

NBL to 2 October: Lilo was again the most advanced (figure 2) confirming that it does have very fast flower development as all cultivars can be assumed to have been induced to flower at the same time. Glenda showed a similar rate of development, followed by Francesca, Freedom and Fireking.

NBL to 12 October: Lilo and Glenda were again the most advanced (figure 3) followed by Francesca and Freedom.

3.1.2 Dates of N/S induction

The graphs illustrated in figures 1 to 3 were used to estimate the approximate date on which each of the cultivars reached stage 2 and stage 3. Since the dates of probable induction were known (2/10 and 12/10), the number of days to reach stages 2 and 3 could be calculated. These numbers of days were then used to work back from when N/S plants reached stages 2 and 3 to give estimates of dates of N/S induction. An example of this procedure can be found in full in the report for project PC71.

Estimated induction dates based on this type of extrapolation are summarised in tables 4 and 5, page 17.

Figure 1. Apical flower stage, Natural season

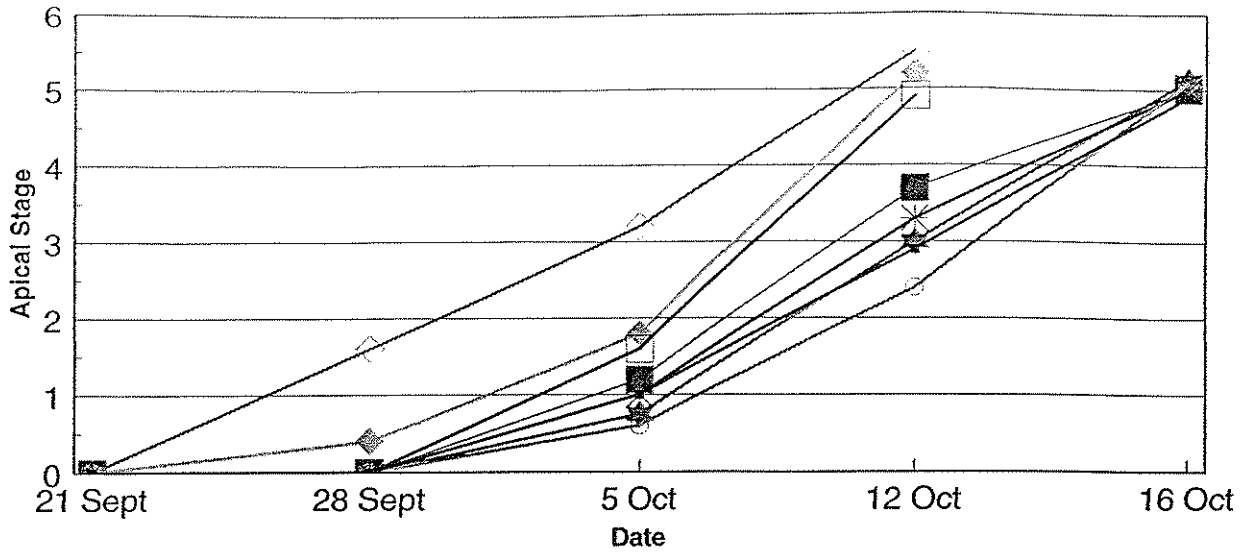


Figure 2. Apical flower stage, NBL to 2 October

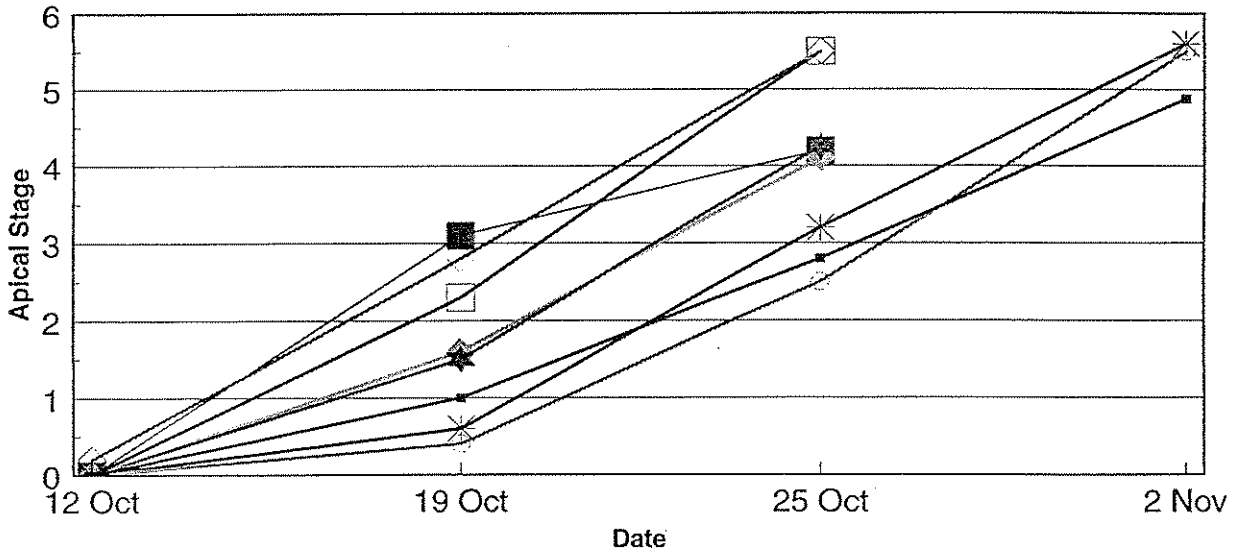


Figure 3. Apical flower stage, NBL to 12 October

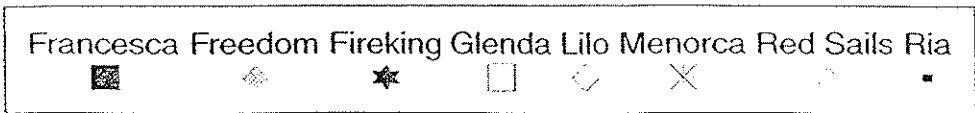
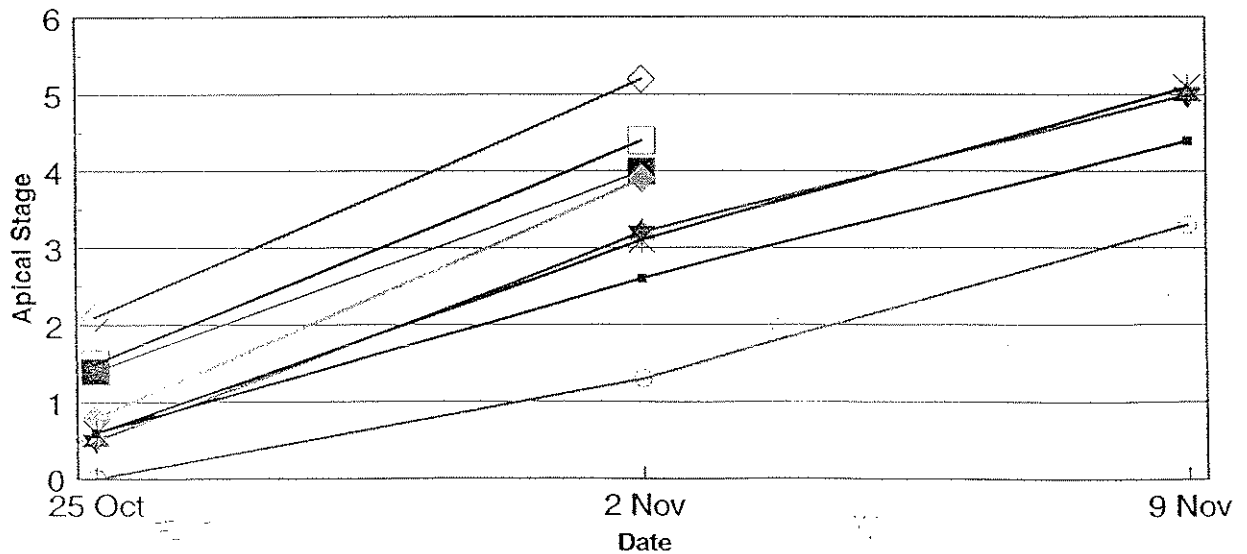


Table 4 Estimates of N/S induction date based on NBL to 2/10

Cultivar	(Fig 1) N/S date to reach:		Based on NBL 2/10 SD to reach:		N/S initiation date based on:	
	Stg 2	Stg 3	Stg 2	Stg 3	Stg 2	Stg 3
	Francesca	7/10	10/10	14	17	23/9
Freedom	5/10	7/10	18	20	17/9	17/9
Fireking	9/10	12/10	18	20	21/9	22/9
Glenda	6/10	8/10	16	18	20/9	20/9
Lilo	30/9	4/10	15	17	15/9	17/9
Menorca	8/10	11/10	20	22	18/9	19/9
Red Sails	10/10	13/10	22	24	18/9	19/9
Ria	9/10	12/10	20	24	19/9	18/9

Table 5 Estimates of N/S induction date based on NBL to 12/10

Cultivar	(Fig 1) N/S date to reach:		Based on NBL 12/10 SD to reach:		N/S initiation date based on:	
	Stg 2	Stg 3	Stg 2	Stg 3	Stg 2	Stg 3
	Francesca	7/10	10/10	15	18	22/9
Freedom	5/10	7/10	16	19	19/9	18/9
Fireking	9/10	12/10	17	20	22/9	22/9
Glenda	6/10	8/10	14	17	22/9	21/9
Lilo	30/9	4/10	13	15	17/9	19/9
Menorca	8/10	11/10	17	20	21/9	21/9
Red Sails	10/10	13/10	23	27	17/9	16/9
Ria	9/10	12/10	19	23	20/9	19/9

Table 6 gives an overall estimate of the dates of N/S induction, indicating earliness and the speed of development to the stage where cyathia became visible with microscopic dissection. Table 6 also shows the expected delay from NBL assuming that whilst the speed of bract coloration may not be the same as the speed of flower development, it can only begin once flowering has been induced.

Table 6 Overall estimates of N/S induction

Cultivar	1992	1993	Induction†/ development*	Expected delay (days)	
				NBL to 2/10	NBL to 12/10
Francesca	-	22-23/9	L/F	9-10	19-20
Freedom	-	17-19/9	E/F	13-15	23-25
Fireking	-	21-22/9	L/M	10-11	20-21
Glenda	-	20-22/9	L/F	10-12	20-22
Lilo	17/9	15-19/9	E/F	13-17	23-27
Menorca	-	18-21/9	M/M	11-14	21-24
Red Sails	24/9	16-19/9	E/S	13-16	23-26
Ria	-	18-20/9	M/M	12-14	22-24

† N/S initiation: E = Early, M = Mid, L = Late

* Development to microscopic visible stage: F = Fast, M = Mid, S = Slow

Freedom is an early cultivar for marketing purposes, but it is not faster to flower than Lilo.

Lilo is the earliest cultivar to show induction of flowers (15-19/9), and showed the same date as in 1992 (17/9).

Red Sails may be slow to show flowers, but it does induce them early (16-19/9). The estimate for 1992 (PC71) was later (5 days) which probably indicates natural variation from year to year for N/S flowering.

3.1.3 Leaf Numbers

Since all treatments were pinched on the same date, the NBL plants can be expected to have more leaves on a shoot since they had a longer vegetative growth phase (table 7). Note that these leaf numbers include the three primary bracts below the terminal cyathium.

Table 7 Average leaf numbers (including primary bracts) below cyathium

Cultivar	NS	NBL to 2/10	NBL to 12/10
Francesca	14.15 (13)	15.70 (10)	18.40 (10)
Freedom	13.17 (12)	15.80 (10)	18.00 (9)
Fireking	16.64 (11)	20.50 (8)	22.75 (12)
Glenda	16.10 (10)	19.90 (10)	21.40 (10)
Lilo	15.00 (15)	18.82 (11)	21.67 (9)
Menorca	15.79 (14)	19.35 (13)	21.15 (13)
Red Sails	14.38 (13)	17.17 (12)	18.50 (8)
Ria	13.57 (14)	16.92 (12)	18.15 (13)
Mean	14.85	18.02	20.00

() = No. flowering samples

From Table 7 a leaf number increment can be established; NS to NBL to 2/10 = 3.17 and NBL 2/10 to NBL 12/10 = 1.98 (c. 0.2 leaves/day).

3.2 Main Trial - HRI Efford

3.2.1 Marketing

There were no significant effects of the calcium chloride sprays at the marketing stage and therefore the effects of the aerial environment treatments are averaged across these. Full tabular results are presented in Appendix V, pages 36 to 44.

Number of heads and their size distribution

The number of bract heads were not affected by the cultural treatments, however, there were highly significant effects of both variety and the use of NBL on their size distribution.

In the cultivar Red Sails the application of NBL increased the average diameter of individual heads, this was in contrast where bract size in this normally early cultivar was reduced where NBL was used. As there were no significant effects of the humidity regimes on 'head' diameter the results of NBL can be seen in tables 15 to 18, Appendix VI, pages 40 to 43.

Overall Quality

At the point of marketing none of the treatments applied in this study had a significant effect on plant quality.

Plant spread

As with plant height there was a strong interaction between cultivar and the use of NBL on plant spread at marketing. The response was, however, less consistent with some cultivars increasing their spread where NBL was used whilst others were normal, see table 8.

Table 8 Effect of NBL on plant spread at marketing measured at the widest (mm)

Cultivar	Height (mm)	
	NS	NBL (10 & 20 days)
Red Sails	376	399
Freedom	360	371
Lilo	334	346
Fireking	374	407
Ria	396	377
Peterstar	324	372

Humidity regimes had no effect on plant spread.

Plant Height

Despite the use of chlormequat there was a significant effect of NBL on plant height, although common to all varieties the degree of effect was cultivar dependent. The use of NBL on the variety Fireking resulted in plants at marketing that were, on average, 71mm taller. The height of Ria was increased by an average of 29mm (table 9).

Table 9 Effect of NBL on plant height (mm) at marketing

Cultivar	Height (mm)	
	NS	NBL (10 & 20 days)
Red Sails	242	285
Freedom	256	314
Lilo	213	256
Fireking	252	323
Ria	220	248
Peterstar	199	252

Humidity regimes had no effect on plant height.

3.2.2 Shelf-life

Due to insufficient replication shelf-life data were not subject to formal statistical analyses, results should therefore be interpreted with caution.

Results were largely inconclusive showing little if any effect of the cultural treatments including the use of calcium chloride sprays which, it was hypothesised, may reduce the level of bract necrosis.

The incidence of bract necrosis and another major shelf-life defect, premature leaf drop, are presented in Appendices VI and VII respectively (pages 45 to 56).

B. Commercial Trialling

3.3 Cultivar Assessments

3.3.1 Marketing

Results from commercial assessments are summarised in Appendix VIII, page 57-59.

4. DISCUSSION

Previous work (PC 71) has shown that many new Poinsettia cultivars have short response times and thus colour too early for the traditional UK Christmas market. In this trial the use of night break lighting (NBL) was further evaluated as a means of delaying floral induction.

Using N/S production techniques Lilo, consistent with 1992 (PC 71) was the fastest cultivar to show development of cyathia closely followed by the cultivars Freedom and Glenda. However, this need not necessarily reflect the speed of floral induction since cultivars differ in their speed of floral development once induced.

Where plants were NBL until 2 October all plants can be assumed to have initiated at the same date. The fact that Lilo was again the most advanced confirms that it does indeed possess very rapid floral development. The cultivar Glenda was similarly fast.

Dates of induction could be calculated for NBL crops since all crops could be assessed at the same point. These dates could then be used to back calculate and determine the point of induction of the cultivars under N/S conditions.

Freedom has consistently been shown to be an early cultivar for marketing purposes, but it is not faster to flower than Lilo. Lilo is the earliest cultivar with flower induction occurring between 15-19 September (17/9 in 1992). In contrast, Red Sails is slow to show flowers but does induce them early (16-19/9), this was five days earlier than the preceding study (PC 71) and probably indicates natural variation from year to year for N/S flowering. Bright conditions around the equinox will delay flowering, dull conditions will advance flowering.

Delayed floral induction by the use of NBL increased the average leaf number below the cyathium by three when comparing N/S with NBL for 10 days and five when comparing N/S with NBL for 20 days. Differences in leaf number were reflected in different plant heights at marketing, those receiving NBL being taller.

The effects of humidity treatments during production and the application of calcium chloride from bract colouring had little impact on the incidence of bract edge necrosis, one of the primary objectives of the trial. However, the removal of sleeves prior to entering shelf-life may have acted to reduce the incidence of this disorder.

5. CONCLUSIONS

- NBL for either 10 or 20 days, subject to cultivar, was again shown to be an effective means of manipulating floral induction and hence scheduling cultivars for the Christmas market.
- Apical dissection enabled the point of initiation of cultivars to be accurately determined.
- The use of night break lighting had a tendency to increase plant height and spread. The latter could be attributed to a greater number of leaves below the cyathium where initiation had been delayed by NBL.
- Positive humidification of the crop during production had no consistent effect on the incidence of bract edge necrosis.
- Consequently the application of calcium chloride prior to marketing confirmed no benefit in terms of reducing this disorder.

APPENDICES

APPENDIX I

Crop Diary

Treatment: Natural season, ambient RH on ebb and flood floors

16.08.93 Potted Fireking, Gladys, Glenda, Francesca.
 28.03.93 Combined drench using Nemasys and Fongarid at rate of 1 bag Nemasys plus 145 grammes of Fongarid.
 24.08.93 Fireking, Gladys, Glenda pinched Fireking to 5 leaves rest to 6. Covered with fleece.
 26.08.93 Francesca pinched to 6 leaves and covered with fleece.
 31.08.93 Aaterra applied as drench at rate of 1g/litre.
 02.09.93 Plots laid out.
 03.09.93 Cycocel 1m/l + spreader 0.5 ml/l.
 06.09.93 Cycocel 1m/l + spreader 0.5 ml/l.
 10.09.93 Cycocel 1m/l + spreader 0.5 ml/l.
 11.09.93 Feed started.
 13.09.93 Cycocel 1.5 ml/l on Glenda & Fireking only, rest 1ml/l + spreader 0.5 ml/l.
 17.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l on Fireking, Glenda and Gladys. Rest have Cycocel at 1.0ml/l + spreader 0.5 ml/l.
 20.09.93 Cycocel + spreader spray as for 17.09.93
 21.09.93 First set of plants taken for initiation studies 5 of 7 cvs.
 24.09.93 Cycocel + spreader. Not Ria. Freedom, Menorca.
 27.09.93 Same as for 24.09.93 - Cycocel + spreader.
 28.09.93 Second batch of samples to Littlehampton.
 29.09.93 Nemasys applied as drench - 1 bag in 200 litres of water to cover 2000 pots.
 30.09.93 Fireking spaced to 20 cm.
 01.10.93 Cycocel + spreader.
 04.10.93 Cycocel + spreader as for 01.10.93.
 05.10.93 Third batch of samples to Littlehampton.
 08.10.93 Cycocel + spreader as for 04.10.93.
 11.10.93 Spacing all varieties to 22 cm.
 12.10.93 Fourth batch of sample plants sent to Littlehampton.
 12.10.93 Cycocel + spreader.
 14.10.93 Spacing all varieties to 30 cm.
 16.10.93 Samples taken Menorca, Red Sails, Francesca, Fireking, Ria.
 15.10.93 Cycocel + spreader.
 03.11.93 First calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.

APPENDIX I

Crop Diary

Treatment: Natural season, ambient RH on ebb and flood floors (continued)

- 10.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.
- 17.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.
- 24.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.
- 25.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Red Sails, Freedom, Ria. Single spray prior to marketing.
- 29.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Lilo only. Single spray prior to marketing.
- 30.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Fireking, Peterstar only.
- 01.12.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on all weekly.

APPENDIX I

Crop Diary

Treatment: K5 NBL 10 days, grown on ebb and flood floors

- 19.08.93 Plants arrived and potted.
- 23.08.93 Combined drench of Nemasys and Fongarid at rate of 1 bag Nemasys plus 145 grams of Fongarid in 200 litres of water.
- 31.08.93 Aaterra applied as drench at rate of 1g/litre.
- 02.09.93 Plots laid out.
- 03.09.93 Cycocel 1m/l + spreader 0.5 ml/l.
- 06.09.93 Cycocel 1m/l + spreader 0.5 ml/l.
- 09.09.93 Spacing all varieties to 17 cm.
- 10.09.93 Cycocel 1m/l + spreader 0.5 ml/l.
- 11.09.93 Feed started.
- 13.09.93 Cycocel 1.5 ml/l on Fireking & Glenda only. Rest have 1ml/l of Cycocel + 0.5 ml/l of spreader.
- 17.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l on Fireking and Glenda only. Rest have Cycocel at 1.0ml/l + spreader 0.5 ml/l.
- 20.09.93 Cycocel + spreader spray as for 17.09.93.
- 27.09.93 Cycocel + spreader as for 24.09.93.
- 29.09.93 Nemasys applied as drench - 1 bag in 200 litres of water to cover 2000 pots.
- 30.09.93 Fireking spaced to 20 cm approx.
- 01.10.93 Cycocel + spreader as for 27.09.93.
- 08.10.93 Cycocel + spreader as for 01.10.93
- 11.10.93 Spacing all varieties to 22 cm.
- 12.10.93 First batch of samples and compost samples sent to Littlehampton.
- 14.10.93 Spacing all varieties to 30 cm.
- 15.10.93 Cycocel 1ml/l + spreader 0.5 ml/l for Menorca, Red Sails, Lilo, Peterstar, Francesca and Freedom. 2ml/l of Cycocel + spreader 0.5 ml/l for Fireking, Glenda, Gladys.
- 19.10.93 Second batch of initiation samples sent.
- 20.10.93 Cycocel + spreader as 15.10.93.
- 22.10.93 Cycocel and spreader as 20.10.93.
- 25.10.93 Initiation samples taken.
- 25.10.93 Cycocel + spreader as for 22.10.93.
- 27.10.93 Cycocel at 3ml/l + spreader 0.5 ml/litre for Fireking only.
- 29.10.93 Cycocel + spreader as for 27.10.93
- 02.11.93 Cycocel 3 ml/l + spreader 0.5 ml/l Fireking and Red Sails. Cycocel 1.5 ml/l + spreader 0.5 ml/l Peterstar, Freedom, Lilo, Ria

APPENDIX I

Crop Diary

Treatment: K5 NBL 10 days, grown on ebb and flood floors (continued)

- 03.11.93 First calcium spray 2.2 g/l + spreader 0.5 ml/l on Freedom.
- 10.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l weekly.
- 17.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l weekly.
- 24.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Freedom and Red Sails.
- 25.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Red Sails, Freedom, Ria. Single spray prior to marketing.
- 01.12.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Peterstar, Red Sails, Freedom, Lilo - weekly.
- 08.12.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l weekly for Peterstar, Lilo, Red Sails, Freedom only.

APPENDIX I

Crop Diary

Treatment: K9; Natural season with ambient RH, grown on benches

02.09.93 Plots laid out.

03.09.93 Cycocel 1m/l + spreader 0.5 mg/l applied

06.09.93 Cycocel 1m/l + spreader 0.5 mg/l applied

09.09.93 Spacing all varieties to 17 cm.

10.09.93 Cycocel 1m/l + spreader 0.5 ml/l.

11.09.93 Feed started.

13.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l on Fireking & Glenda only. Rest have 1ml/l of Cycocel + 0.5 ml/l of spreader.

17.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l.

20.09.93 Cycocel + spreader spray as for 17.09.93

27.09.93 Cycocel + spreader as for 20.09.93.

29.09.93 Nemasys applied as drench - 1 bag in 200 litres of water to cover 2000 pots.

30.09.93 Fireking spaced to 20 cm approx.

01.10.93 Cycocel + spreader as for 27.09.93.

04.10.93 Cycocel + spreader as for 01.10.93.

08.10.93 Cycocel + spreader as for 04.10.93

11.10.93 Spacing all varieties to 22 cm.

14.10.93 Spacing all varieties to 30 cm.

03.11.93 First calcium spray 2.2 g/l + spreader 0.5 ml/l weekly.

10.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l weekly.

17.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l weekly.

19.11.93 Chrysal EVB 5 ml/l + Argylene STS 1.5 g/l on those labelled. 3 STS + 3 Chrysal EVB from each variety.

24.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.

25.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Freedom, Red Sails, Ria only. Single spray prior to marketing.

29.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Lilo. Single spray prior to marketing.

30.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Fireking and Peterstar. Single spray prior to marketing.

01.12.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on all weekly.

APPENDIX I**Crop Diary**

Treatment: K10; Natural season with positive RH, grown on ebb and flood floors

- 19.08.93 Plants arrived and potted.
- 23.08.93 Combined drench using Nemasys and Fongarid at rate of 1 bag Nemasys plus 145 grams of Fongarid to cover 2000 plants in 200 litres of water.
- 26.08.93 Sprayed Rovral on Freedom only at 1 ml/l.
- 31.08.93 Aaterra applied as drench at rate of 1g/litre.
- 03.09.93 Pots spaced and Cycocel 1m/l + spreader 0.5 mg/l applied.
- 06.09.93 Cycocel 1m/l + spreader 0.5 mg/l applied.
- 09.09.93 Spacing all varieties to 17 cm.
- 10.09.93 Cycocel 1m/l + spreader 0.5 ml/l.
- 11.09.93 Feed started.
- 13.09.93 Cycocel 1.5 ml/l on Fireking & Glenda.
- 17.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l on Glenda, Fireking, Gladys. Rest have Cycocel at 1.0ml/l + spreader 0.5 ml/l.
- 20.09.93 Cycocel + spreader spray as for 17.09.93
- 27.09.93 Cycocel + spreader as for 20/09/93.
- 29.09.93 Nemasys applied as drench - 1 bag in 200 litres of water to cover 2000 pots.
- 30.09.93 Fireking spaced to 20 cm approx.
- 04.10.93 Cycocel + spreader as for 20.09.93.
- 04.10.93 Gladys spaced to 20 cm.
- 08.10.93 Cycocel + spreader as for 04.10.93
- 11.10.93 Spacing all varieties to 22 cm.
- 14.10.93 Spacing all varieties to 30 cm.
- 03.11.93 First calcium spray 2.2 g/l + spreader 0.5 ml/l weekly.
- 10.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l weekly.
- 17.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.
- 24.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.
- 25.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Freedom, Red Sails, Ria only. Single spray prior to marketing.
- 29.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Lilo only. Single spray prior to marketing.
- 30.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Freedom, Peterstar. Single spray prior to marketing.
- 01.12.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on all weekly.

APPENDIX I

Crop Diary

Treatment: K15; NBL 20 days, grown on ebb and flood floors

02.09.93 Plots laid out.

03.09.93 Cycocel 1m/l + spreader 0.5 mg/l applied.

06.09.93 Cycocel 1m/l + spreader 0.5 mg/l applied.

10.09.93 Spacing all varieties to 17 cm.

10.09.93 Cycocel 1m/l + spreader 0.5 ml/l.

11.09.93 Feed started.

13.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l on Fireking & Gladys only. Rest have 1ml/l of Cycocel + 0.5 ml/l of spreader.

17.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l.

20.09.93 Cycocel + spreader spray as for 17.09.93.

27.09.93 Cycocel + spreader as for 20.09.93.

29.09.93 Nemasys applied as drench - 1 bag in 200 litres of water to cover 2000 pots.

30.09.93 Fireking spaced to 20 cm approx.

01.10.93 Cycocel + spreader as for 27.09.93.

04.10.93 Cycocel + spreader as for 01.10.93.

08.10.93 Cycocel + spreader as for 04.10.93

11.10.93 Spacing all varieties to 22 cm.

14.10.93 Spacing all varieties to 30 cm.

22.10.93 Cycocel + spreader as for 20.10.93

25.10.93 Cycocel + spreader as for 22.10.93

27.10.93 Cycocel at 3 ml/l + spreader at 0.5 ml/l.

29.10.93 Cycocel + spreader 3 ml/l of Cycocel + spreader 0.5 ml/l. Cycocel 1.5 ml/l + spreader 0.5 ml/l.

02.11.93 Cycocel 3 ml/l + spreader 0.5 ml/l Fireking, Red Sails. Cycocel 1.5 ml/l + spreader 0.5 ml Peterstar, Freedom, Lilo, Ria.

17.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Freedom.

24.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.

01.12.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l on Lilo, Freedom, Red Sails.

08.12.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l weekly.

APPENDIX I**Crop Diary****Treatment: K16; Natural season with humidification, grown on benches**

02.09.93 Plots laid out.

03.09.93 Cycocel 1m/l + spreader 0.5 mg/l applied.

06.09.93 Cycocel 1m/l + spreader 0.5 mg/l applied.

10.09.93 Spacing all varieties to 17 cm.

10.09.93 Cycocel 1m/l + spreader 0.5 ml/l.

11.09.93 Feed started.

13.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l on Fireking & Gladys only.

17.09.93 Cycocel 1.5 ml/l + spreader 0.5 ml/l.

20.09.93 Cycocel + spreader spray.

27.09.93 Cycocel + spreader as for 20.09.93.

29.09.93 Nemasys applied as drench - 1 bag in 200 litres of water to cover 2000 pots.

30.09.93 Fireking spaced to 20 cm.

01.10.93 Cycocel + spreader as for 27.09.93.

04.10.93 Cycocel + spreader as for 01.10.93.

08.10.93 Cycocel + spreader as for 04.10.93

11.10.93 Spacing all varieties to 22 cm.

14.10.93 Spacing all varieties to 30 cm.

03.11.93 First calcium spray 2.2 g/l + spreader 0.5 ml/l on weekly.

10.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l.

17.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l.

24.11.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l.

25.11.93 Calcium sprays 2.2 g/l + spreader 0.5 ml/l on Red Sails, Freedom, Ria. Single spray prior to marketing.

29.11.93 Calcium sprays 2.2 g/l + spreader 0.5 ml/l on Lilo only. Single spray prior to marketing.

30.11.93 Calcium sprays 2.2 g/l + spreader 0.5 ml/l on Fireking and Peterstar. Single spray prior to marketing.

01.12.93 Calcium spray 2.2 g/l + spreader 0.5 ml/l.

APPENDIX II

Trial Layout

- A. Natural season initiation with ambient humidity on ebb and flood floors - K4.
- B. Initiation delayed by 10 days with night break lighting of 4 hours from pinching with ambient humidity on ebb and flood floors - K5.
- C. Initiation delayed by 20 days with night break lighting of 4 hours from pinching with ambient humidity on ebb and flood floors - K15
- D. Natural season initiation with humidification to 95% RH from bract colouring on ebb and flood floors - K10.
- E. Natural season initiation with ambient humidity on benches - K9.
- F. Natural season initiation with humidification to 95% RH from bract colouring on benches - K16.

Main trial layout - in each compartment

XXXXXXXXXXXX X X X RED SAILS X X	FREEDOM
PETERSTAR	LILO
FIREKING	RIA

N ←

X = Plant

60 plants per variety block

APPENDIX III

The Flowering Stage Scale

This is based on a scale originally developed at Littlehampton by Jon Horridge but was amplified during project PC71.

- Stage 0** Plants appear vegetative. Apex small, rather flat and circular, being closely surrounded by leaf primordia.
- Stage 1** Plants reproductive. Apex assuming a triangular shape (primary cyathium) and somewhat raised above three bract initials. First signs of developing growing points (secondary cyathia) in the axils of one or two of the bracts (not the youngest). Merest hint of staminate primordial development at the tips of the primary apex.
- Stage 2** Obvious growing points in the axils of all three bract initials but these still lack any obvious differentiation. An involucre initial now becoming obvious as a ‘hood’ at one of the corners of the primary apex. Staminate initials now obvious at all three corners.
- Stage 3** Involucre now has an obvious rim all around the primary apex. Centre of the apex becoming domed as the pistillate primordium starts to develop. First signs of staminate primordia other than the original three. Bract primordia becoming obvious on the secondary cyathia.
- Stage 4** Well developed involucre extending upwards from the apex as high as other floral primordia. Five or more staminate initials present plus an obvious pistillate initial.
- Stage 5** Involucre now enclosing the primary cyathium but still with an obvious aperture at the tip. Secondary cyathia have well developed bracts which, in turn, subtend tertiary cyathia initials.
- Stage 6** Involucre fully enclosing the primary cyathium, frequently with the aperture ‘plugged’ by the upwards growth of the pistil.

APPENDIX IV

POINSETTIA

Criteria used for quality grading

Crop: Branched plants in 13 cm pots

	Grade			
	1	2	3	4 (unmkt)
Height (mm)	225-300	<225 - > 300	< 200 - > 350	< 200 - > 400
Bracts (minimum)	5	4	3	< 3
Shape	Symmetrical top horizontal slightly domed	May be slightly asymmetrical	Distinctly asymmetrical	-
Cyathia	Intact	Up to 10% loss	-	-
Bract colour	(1) Typical of variety or dark	(2) Slightly pale	(3) Distinctly pale	
Leaf colour	"	"	"	
Stem strength	(1) Strong	(2) Intermediate	(3) Weak	

APPENDIX V

Table 10 Effect of initiation and humidification treatments on plant height (mm) at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	252	255	315	245	221	249
Freedom	266	286	335	273	245	237
Lilo	206	233	278	224	200	222
Fireking	273	310	337	253	231	250
Ria	231	234	262	214	210	222
Peterstar	204	244	259	203	195	193

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX V

Table 11 Effect of initiation and humidification treatments on plant spread (mm) (widest point) at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	384	387	410	389	351	278
Freedom	393	368	374	348	354	347
Lilo	321	340	352	346	326	342
Fireking	279	399	415	379	359	381
Ria	397	373	382	400	378	408
Peterstar	320	370	374	326	323	323

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX V

Table 12 Effect of initiation and humidification treatments on plant spread (mm) (90° to widest point) at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	292	311	317	289	288	298
Freedom	307	287	310	285	284	276
Lilo	257	264	280	265	279	279
Fireking	299	341	331	295	293	301
Ria	319	301	312	321	294	370
Peterstar	269	310	294	268	259	269

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX V

Table 13 Effect of initiation and humidification treatments on the number of heads at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	5.4	5.7	5.9	5.6	5.3	5.5
Freedom	5.5	5.5	5.2	5.7	5.5	5.4
Lilo	4.9	5.4	5.4	5.4	5.1	4.9
Fireking	4.6	5.2	4.6	4.7	4.8	4.6
Ria	5.7	6.0	5.8	5.7	5.5	5.7
Peterstar	5.8	5.6	5.4	5.8	5.4	5.9

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX V

Table 14 Effect of initiation and humidification treatments on the number of heads of diameter > 225mm at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	0.25	0.5	0.05	0.2	0.05	0.1
Freedom	2.15	1.9	1.75	2.55	2.6	2.35
Lilo	0	0.1	0.25	0.1	0.05	0.3
Fireking	0.05	0	0	0	0	0
Ria	0.05	0	0	0.75	1.0	2.4
Peterstar	0.25	0.55	0.25	0.15	0	0

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX V

Table 15 Effect of initiation and humidification treatments on the number of heads of diameter > 200 < 225 mm at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	2.1	1.65	2.1	2.15	2.3	2.85
Freedom	1.35	2.15	1.25	1.55	1.3	1.6
Lilo	1.10	1.0	1.2	0.75	1.55	1.8
Fireking	0.8	0.1	0	0.8	0.65	1.35
Ria	2.4	1.85	1.65	2.5	2.35	2.2
Peterstar	2.5	1.95	1.90	1.9	1.55	2.05

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX V

Table 16 Effect of initiation and humidification treatments on the number of heads of diameter > 150 < 200mm at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	2.85	2.95	3.0	2.90	2.60	2.30
Freedom	1.4	1.1	1.35	1.0	1.2	1.1
Lilo	2.4	2.75	2.1	2.7	2.6	2.05
Fireking	3.25	1.25	0.7	3.45	2.95	2.7
Ria	2.75	3.05	3.0	2.4	1.9	0.95
Peterstar	2.95	2.2	2.05	3.35	2.7	3.55

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX V

Table 17 Effect of initiation and humidification treatments on the number of heads of diameter < 150mm at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	0.2	0.6	0.7	0.35	0.35	0.25
Freedom	0.65	0.3	0.8	0.55	0.35	0.35
Lilo	1.4	1.6	1.85	1.85	0.9	0.8
Fireking	0.5	3.8	3.9	0.45	1.2	0.6
Ria	0.55	1.05	1.15	0.15	0.25	0.15
Peterstar	0.5	0.85	1.2	0.4	1.1	0.3

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX V

Table 18 Effect of initiation and humidification treatments on overall plant quality (0-3) at marketing

Cultivar	Treatment					
	A	B	C	D	E	F
Red Sails	2.5	2.15	2.35	2.15	2.25	2.0
Freedom	2.25	2.20	2.25	2.30	2.15	2.15
Lilo	2.05	2.0	2.25	2.05	2.15	2.05
Fireking	2.20	2.15	2.30	2.25	2.05	2.25
Ria	2.15	2.35	2.30	2.10	2.15	2.10
Peterstar	2.15	2.3	2.2	2.15	2.25	2.2

Treatments

- A. Natural season initiation with ambient humidity (plants grown on ebb and flood floors).
- B. Initiation delayed by 10 days with night break lighting (NBL) with ambient humidity (plants grown on ebb and flood floors).
- C. Initiation delayed by 20 days with night break lighting NBL with ambient humidity (plants grown on ebb and flood floors).
- D. Natural season initiation, humidification to 95% (plants grown on ebb and flood floors).
- E. Natural season initiation with ambient humidity (plants grown on benches).
- F. Natural season initiation, humidification to 95% (plants grown on benches).

APPENDIX VI

Explanation of axis labels; figures 1 to 5.

WK1-6 = shelf-life wk number

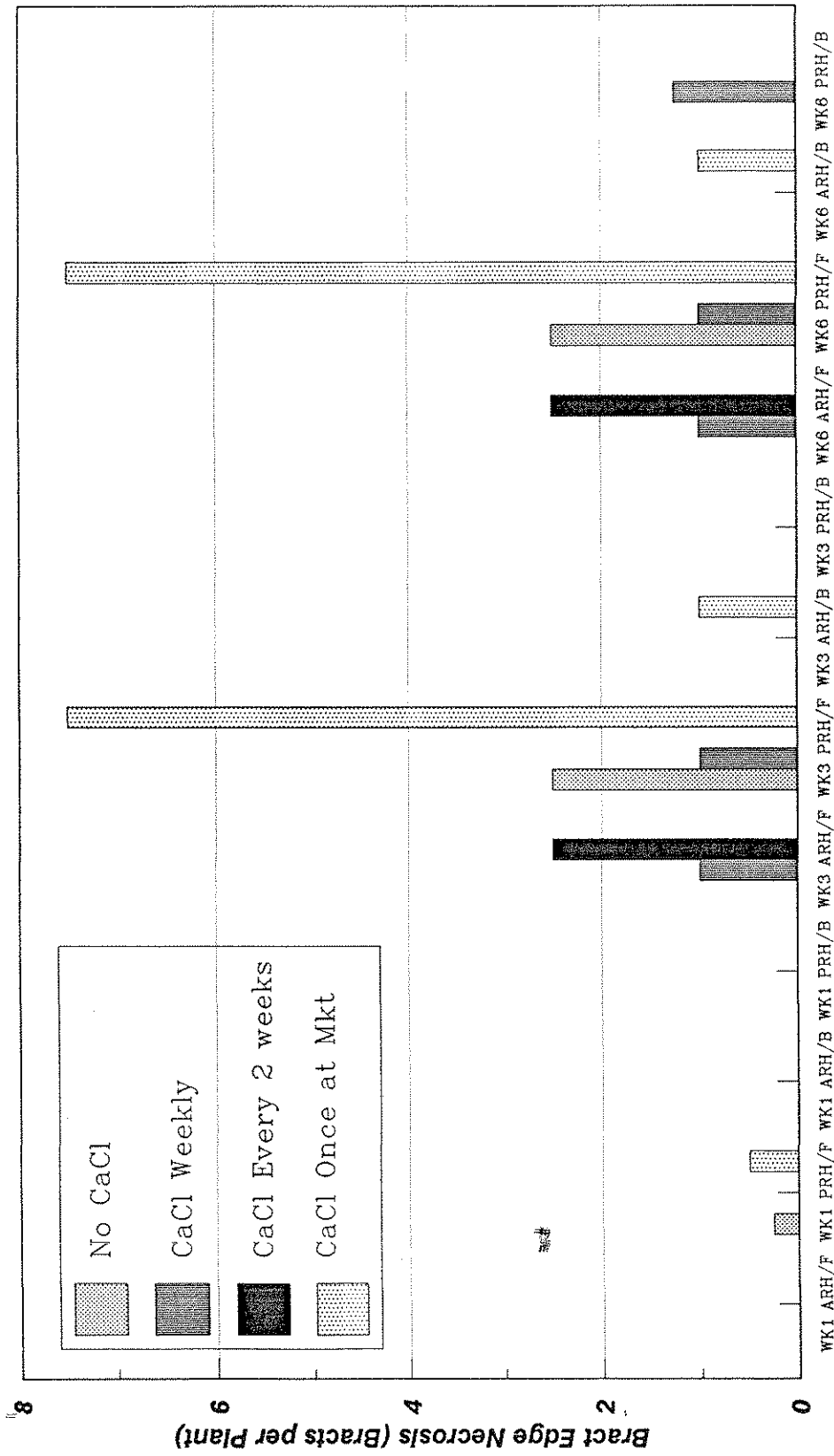
ARH & PRH = ambient or positive humidity

/F & /B = crop grown on floors or benches

45

APPENDIX VI: Figure 1

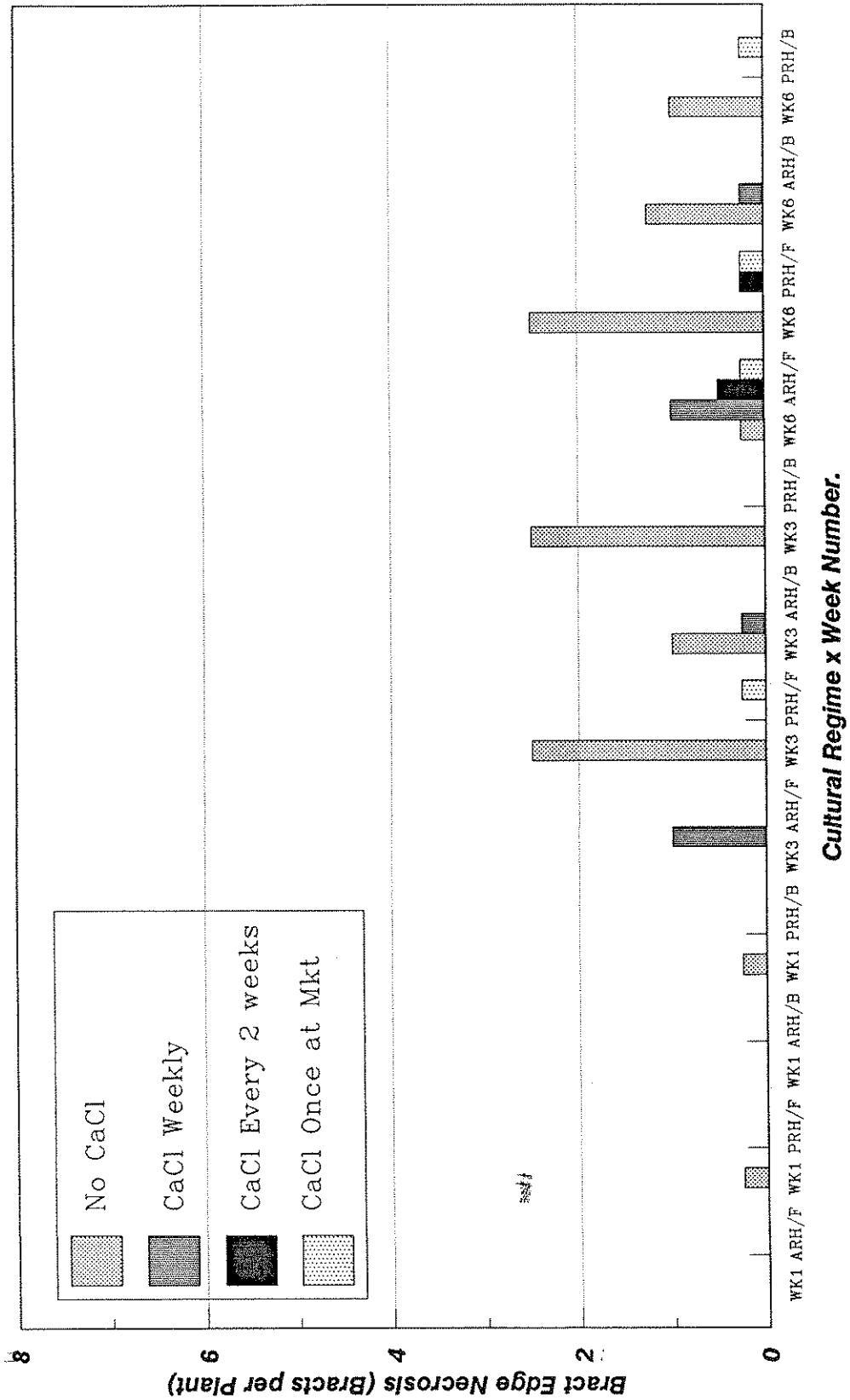
**Effect of cultural treatments on the incidence
of bract edge necrosis during shelf-life
RED SAILS**



Cultural Regime x Week Number.

APPENDIX VI: Figure 2

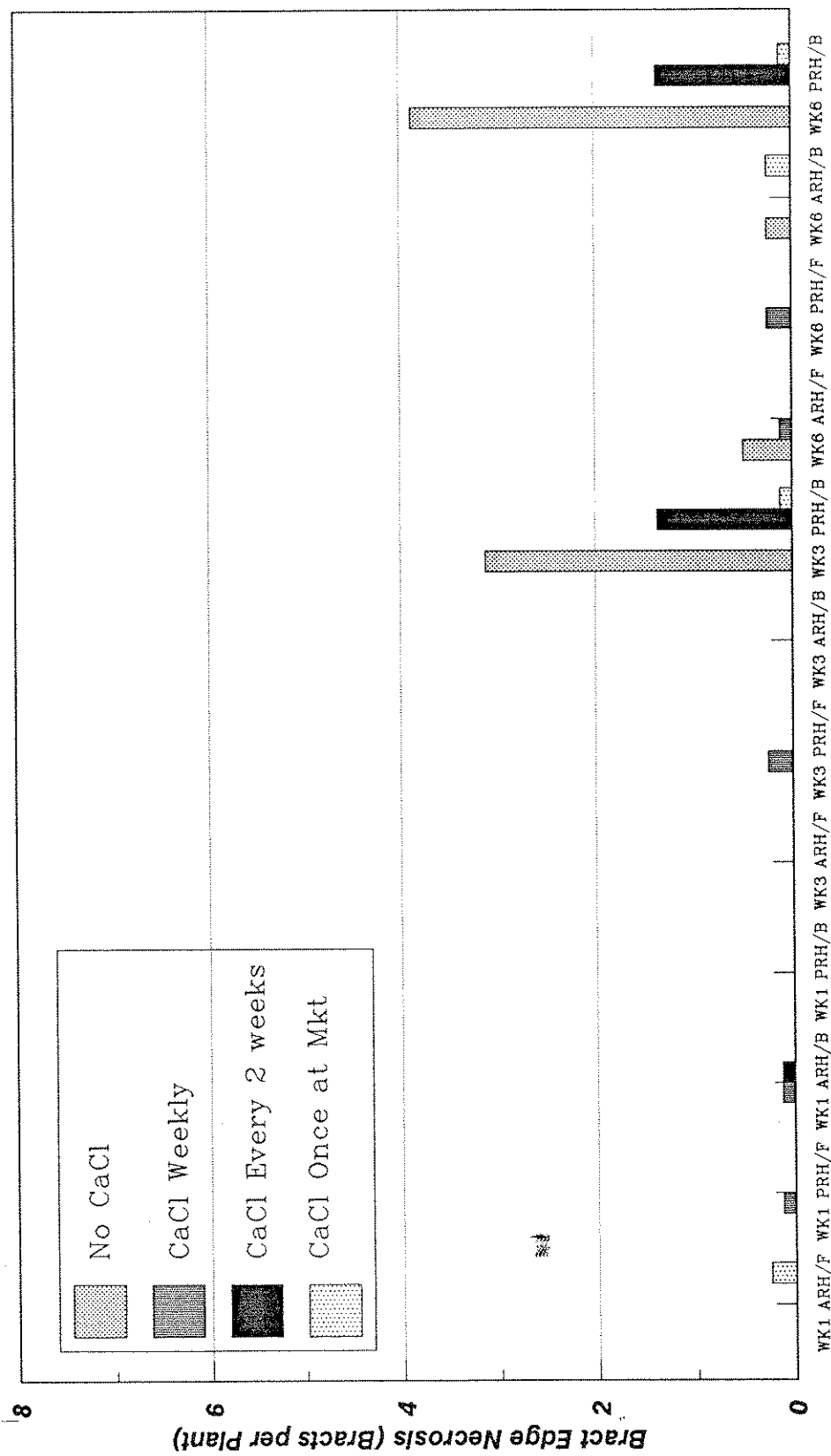
**Effect of cultural treatments on the incidence
of bract edge necrosis during shelf-life
FREEDOM**



APPENDIX VI: Figure 3

Effect of cultural treatments on the incidence of bract edge necrosis during shelf-life

LILO

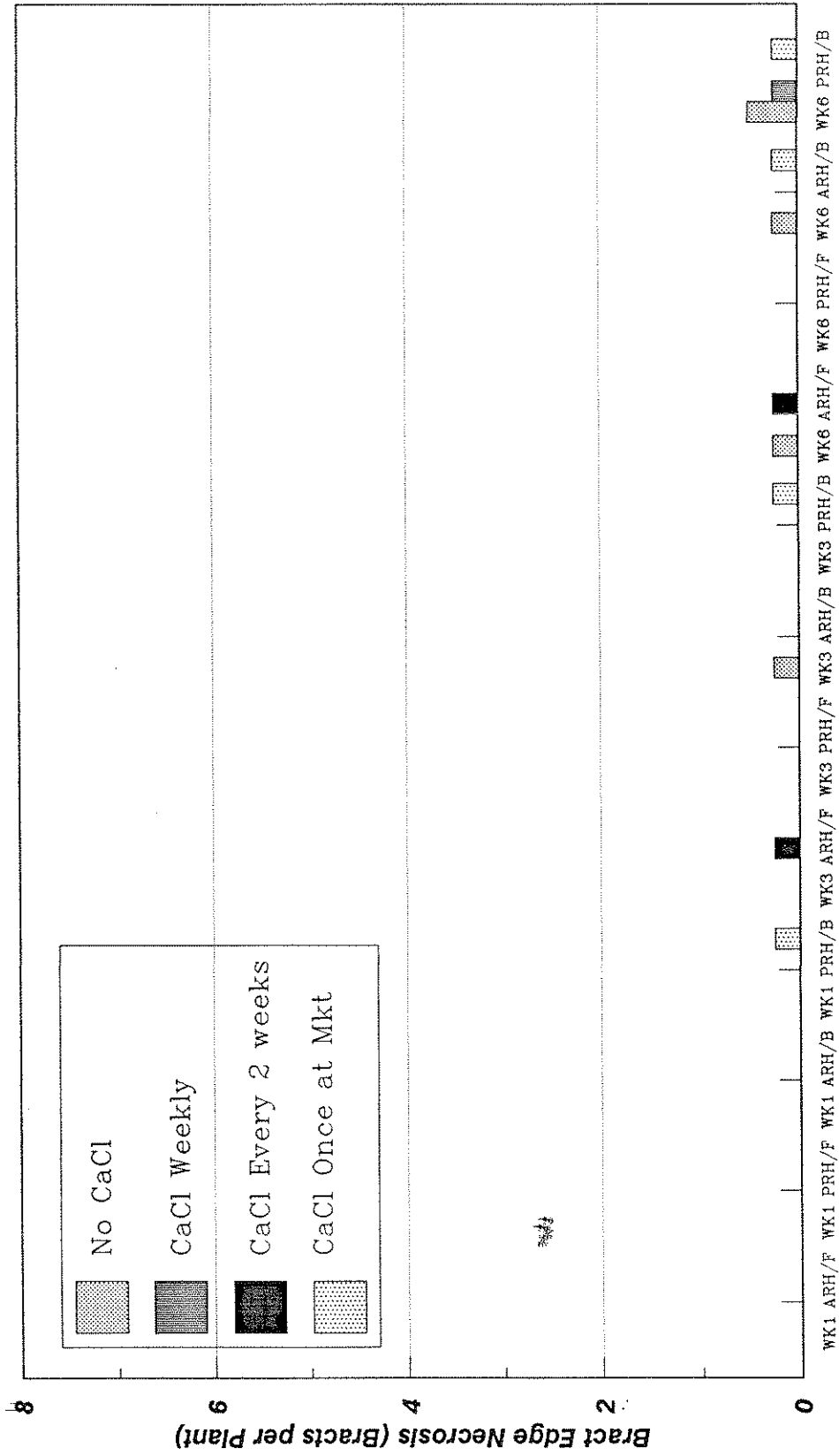


Cultural Regime x Week Number.

APPENDIX VI: Figure 4

Effect of cultural treatments on the incidence of bract edge necrosis during shelf-life

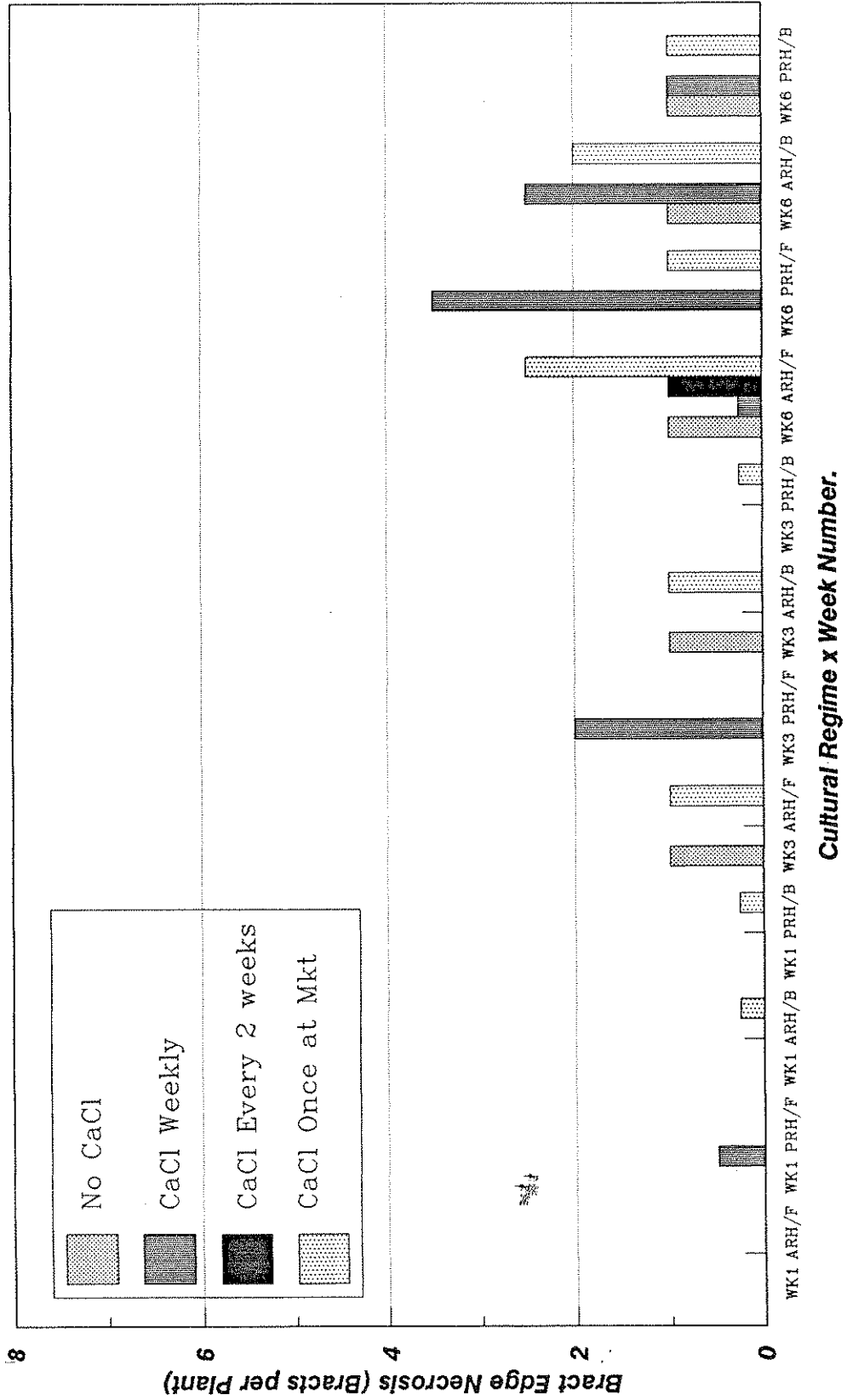
RIA



Cultural Regime x Week Number.

APPENDIX VI: Figure 5

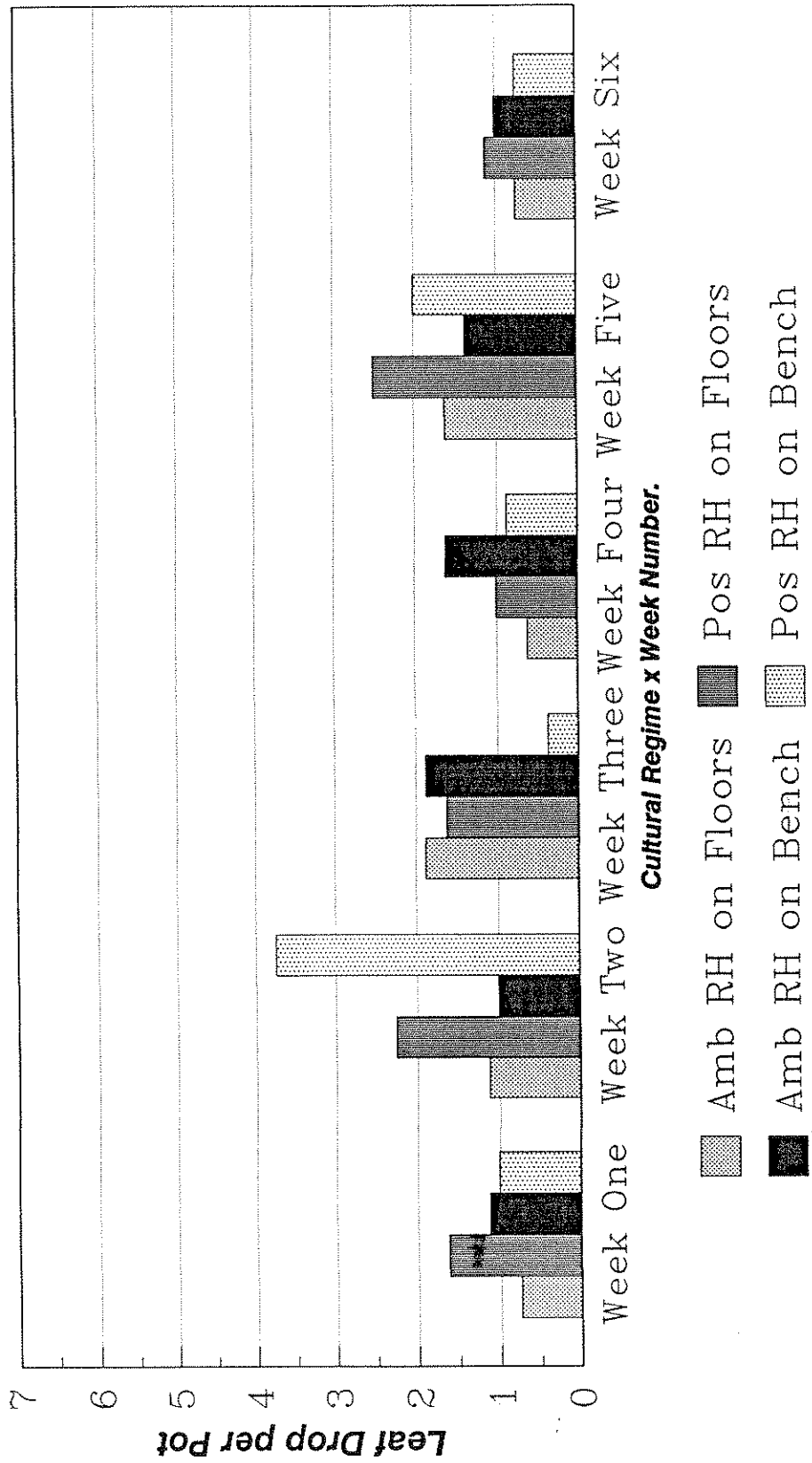
**Effect of cultural treatments on the incidence
of bract edge necrosis during shelf-life
PETERSTAR**



APPENDIX VII: Figure 6

Effect of cultural treatments on the incidence of leaf drop during shelf-life

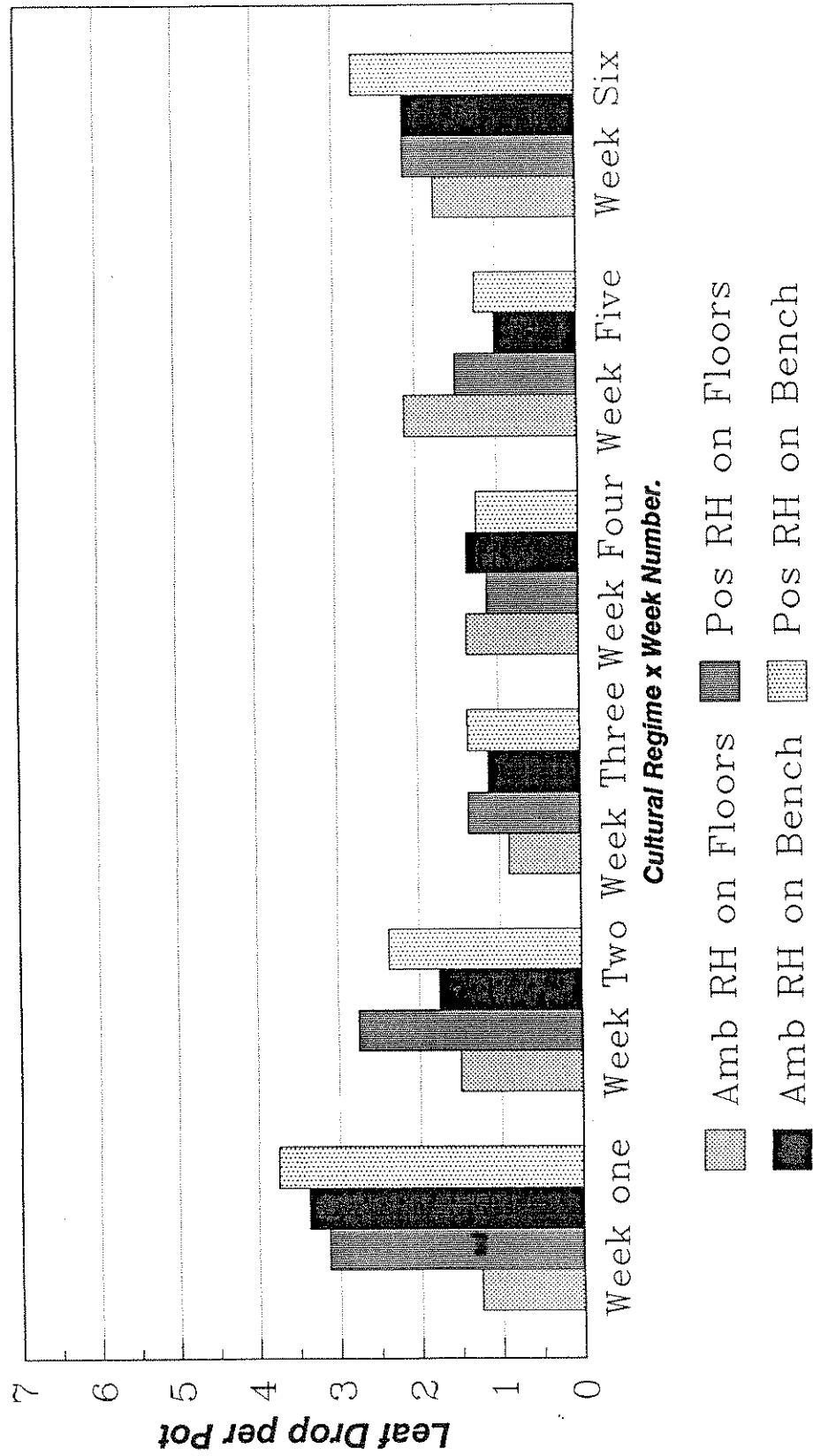
RED SAILS



APPENDIX VII: Figure 7

Effect of cultural treatments on the incidence of leaf drop during shelf-life

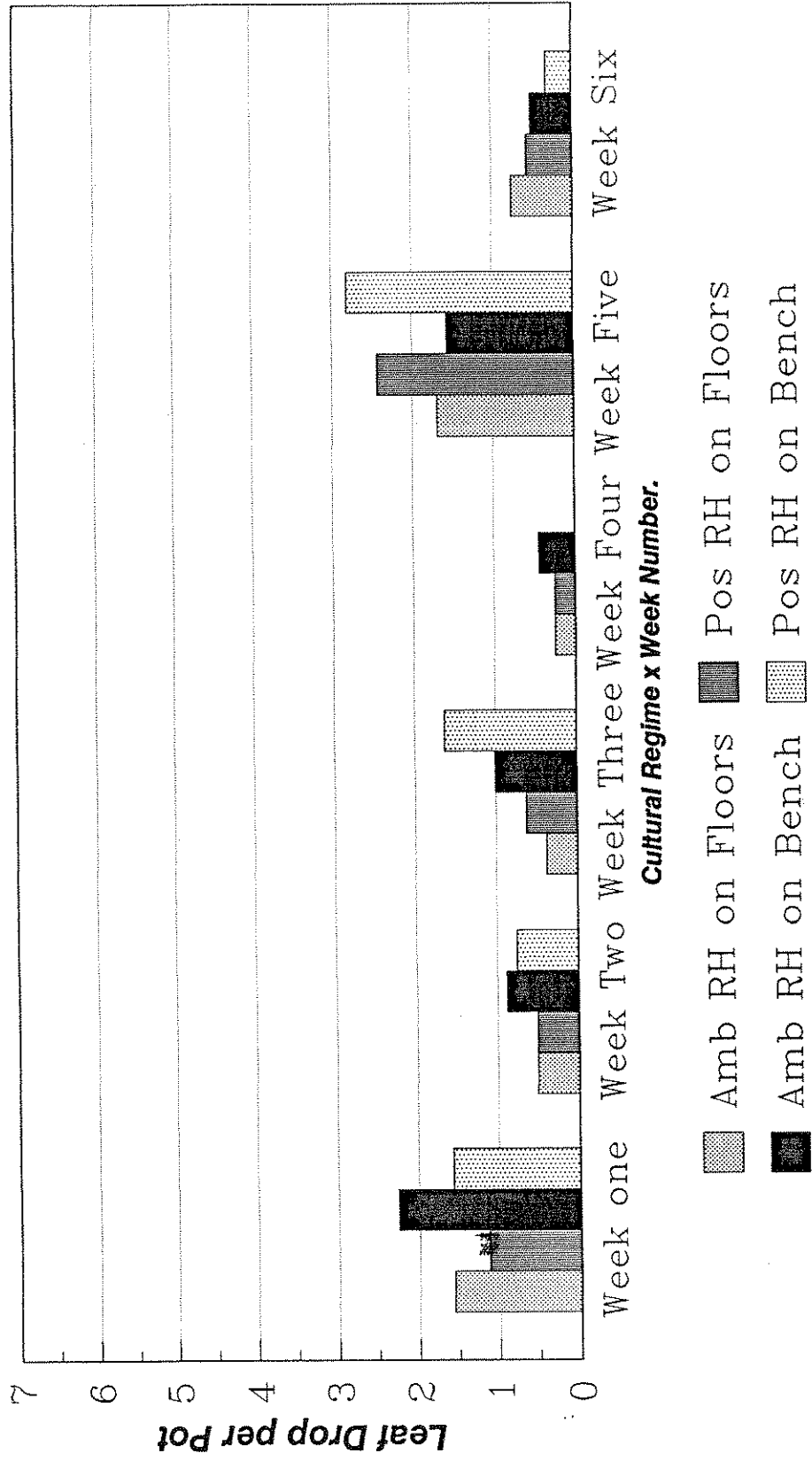
FREEDOM



APPENDIX VII: Figure 8

Effect of cultural treatments on the incidence of leaf drop during shelf-life

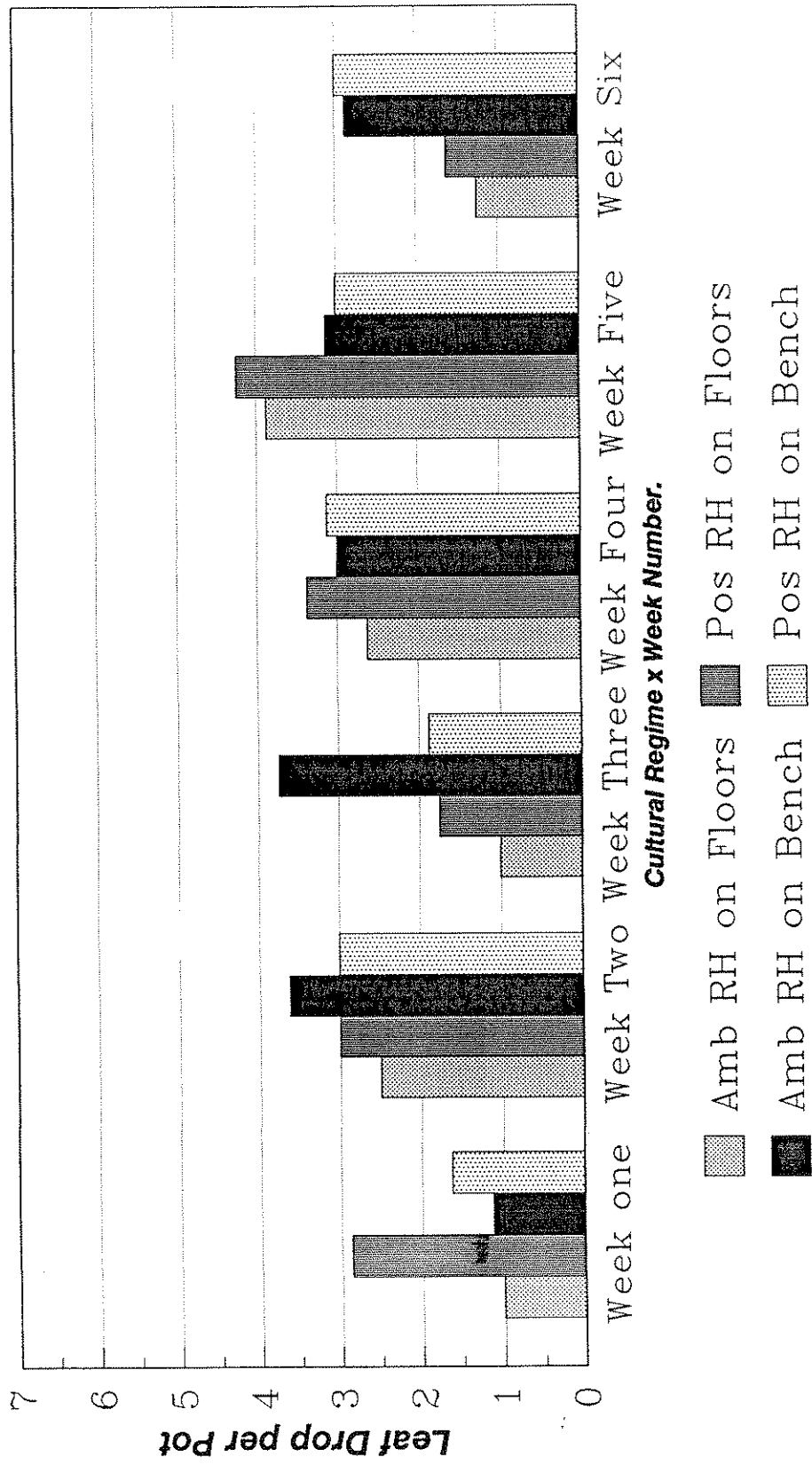
LILO



APPENDIX VII: Figure 9

Effect of cultural treatments on the incidence of leaf drop during shelf-life

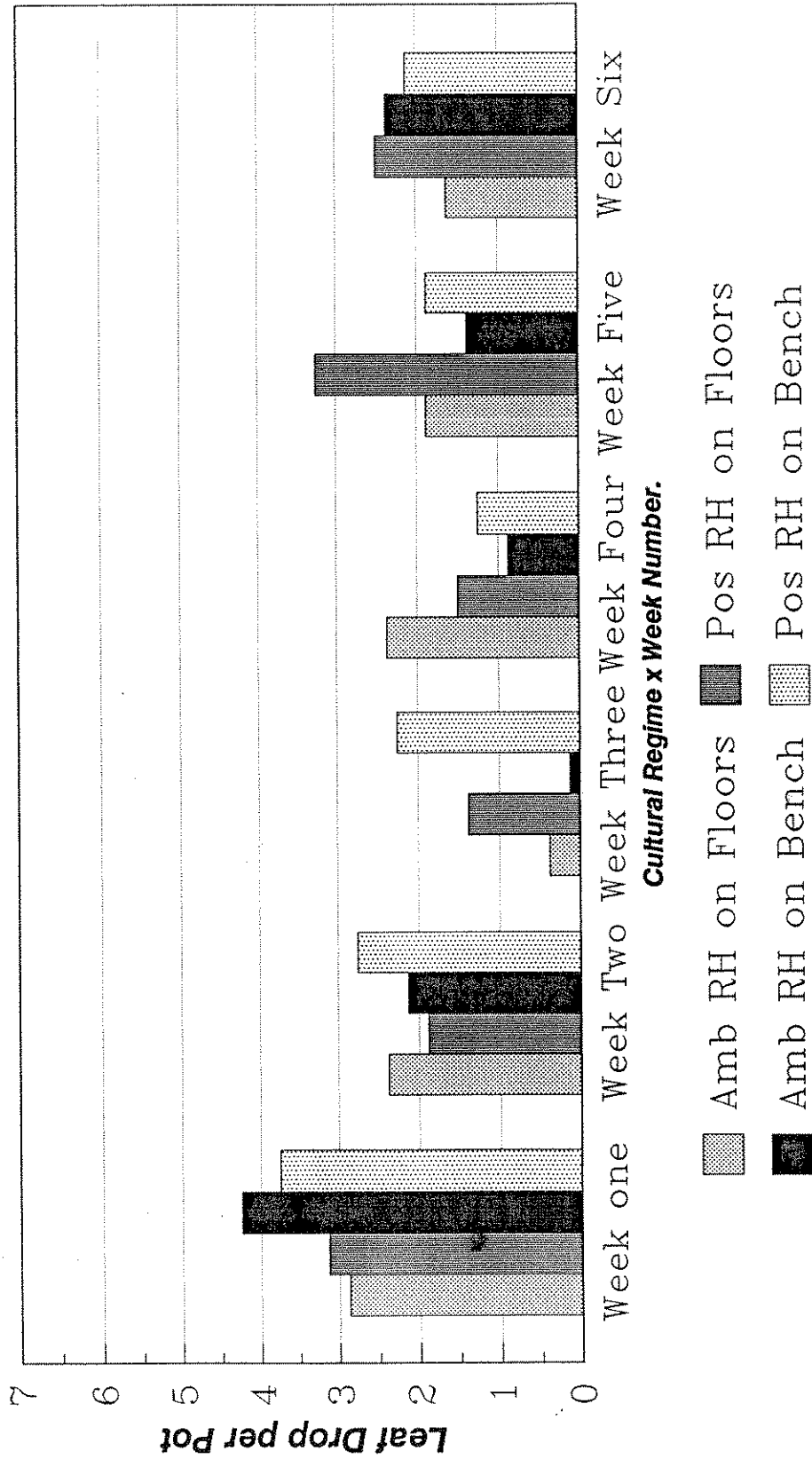
FIREKING



APPENDIX VII: Figure 10

Effect of cultural treatments on the incidence of leaf drop during shelf-life

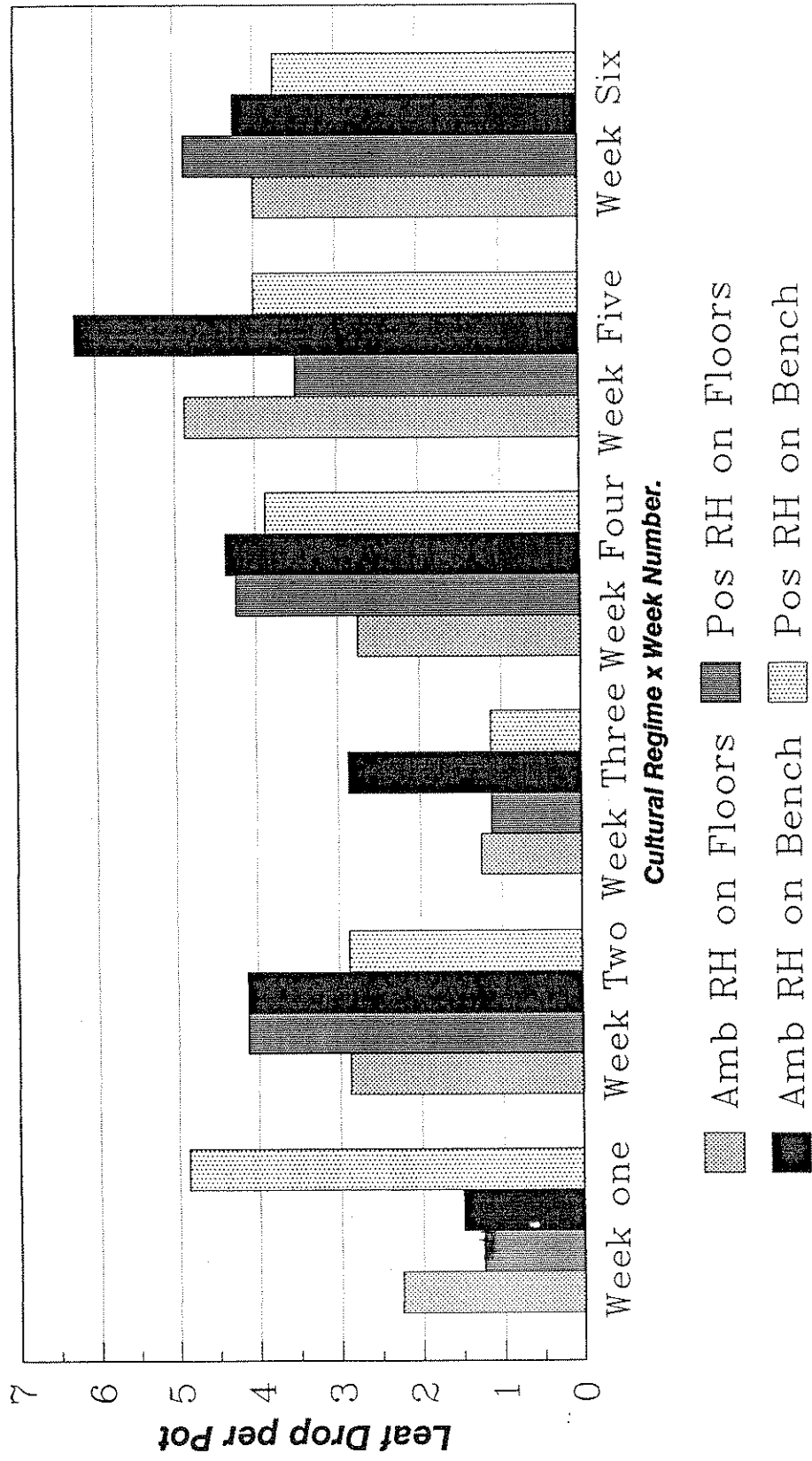
RIA



APPENDIX VII: Figure 11

Effect of cultural treatments on the incidence of leaf drop during shelf-life

PETERSTAR



APPENDIX VIII

Results - Comparison of Varieties

(a) Recorded Hampshire 22 November

Variety	Height	Width	No Stars	Bract size
Reds				
1. Freedom	23.2	35.2	5.5	> 225 mm
2. Lilo	26.4	33.2	5.5	> 225 mm
3. Red Sails	25.8	43.7	5.7	> 225 mm
4. Peterstar	23.1	36.7	6.8	> 225 mm
5. Ria	22.4	40.6	5.6	> 225 mm
6. Francesca	25.5	38.7	5.9	> 200 mm
7. Fireking	29.9	49.3	6.0	> 200 mm
8. Marlene	18.4	41.2	6.8	> 200 mm
9. Menorca	28.4	43.3	5.8	< 150 mm
10. Ibiza	22.0	37.7	5.2	< 200 mm
Mean	24.05	36.9	5.9	
White				
Gladys	26.7	42.8	5.4	< 200 mm
Pink				
Glenda	26.9	44.5	5.6	< 150 mm

(b) Recorded Kent 9 December

Variety	Height	Width	No Stars	Bract size
Reds				
Freedom	20.9	33.2	5.0	> 200 mm
Lilo	27.9	35.7	6.3	> 250 mm
Red Sails	25.3	35.4	5.8	> 250 mm
Peterstar	22.9	36.8	6.6	> 250 mm
Ria	19.9	32.5	4.7	> 200 mm
Francesca	23.5	36.7	5.7	> 200 mm
Fireking	29.9	37.0	5.5	> 200 mm
Marlene				
Menorca	26.2	39.2	4.1	> 200 mm
Ibiza	25.6	35.0	4.0	> 200 mm
Mean	24.7	35.7	5.3	
White				
Gladys	21.6	31.4	7.7	> 200 mm
Pink				
Glenda	29.3	38.0	9.2	> 150 mm

APPENDIX VIII**NOTES ON VARIETIES****FREEDOM**

Short medium cultivar response time eight weeks.

This cultivar has dark coloured leaves and bracts. The cyathia is small. The bracts are pear shaped, can be dull, dull red or even plum coloured under low temperature condition. The bracts are flat, hang down but are of good size.

LILO

Habit medium, response time 8½ weeks. Dark coloured leaves and bracts. Both oak leaf shaped. Some shoots weak. Cyathia prominent and sizes under difficult conditions. This cultivar is not normally free with shoots although in 1993 the number of stars produced was adequate.

RED SAILS

Habit medium tall, flower response time 9 weeks. Dark leaves and dark red bracts. Leaves and bracts oak leaved shaped. Bracts show some crinkling, held erect. Cyathia prominent and held well.

PETERSTAR

Vigorous habit 9 week response group. Light green leaves and light red bracts. Bracts pear shaped. Plants vigorous, cyathia well held and often prominent. Plants tend to be soft and do not travel. Number of shoots on this cultivar in trial, high.

RIA

Habit medium, response group claimed to be 8 weeks. Foliage normal green, bracts bright red. Bracts smooth and long. Durable cyathia. Good shelf life. Plants in trial - short compared to other red cultivar, number of stars low in one trial but adequate in the second trial.

FRANCESCA

Habit vigorous, response group 9 weeks. Colour normal green and dark red bract. Plants poorly furnished with leaves. Bracts tending to be small and not fully developed at the time the records were taken. Although cyathia prominent and shelf^{life} life claimed to be durable. Not suitable for UK market as it is too vigorous.

FIREKING

Habit vigorous, response group 9 weeks. Leaves normal green, bracts dark deep red, brilliant in colour, slightly crinkled. Cyathia prominent. Shelf life claims to be good but under UK conditions bract edge blackening was noted on this cultivar.

MARLENE

Little information available.

MENORCA

Medium size, response group 9 weeks, foliage deep green bracts intense red, medium size with large cyathia, shelf life claimed to be good.

IBIZA

Habit medium size vigorous, response group 8 weeks. Leaves normal green, bracts intense red, medium size with large cyathia.

WHITE

GLADYS

White/cream bracts, light green leaves, habit upright, high number of shoots on side B. Bracts small star shaped, 8 week response group plain.

PINK

GLENDA

Habit vigorous, plants rangy, 9 weeks response group. Normal green leaves, black colour, pink/apricot. Cyathia prominent.

4

APPENDIX IX Copy of contract terms and conditions

Contract between HRI and ADAS (hereinafter called the "Contractors") and the Horticultural Development Council (hereinafter called the "Council") for a research and development project.

1. TITLE OF PROJECT

Contract No: PC71a
Contract date: 14.9.93

TO INVESTIGATE THE RESPONSE OF A RANGE OF POINSETTIA CULTIVARS TO CULTURAL AND CHEMICAL TREATMENTS WITH A VIEW TO IMPROVING PLANT SHELF-LIFE

2. BACKGROUND AND COMMERCIAL OBJECTIVES

The new Poinsettia cultivars generally have a shorter response time from initiation to development of the bract and flower, for example 7.5 weeks for Freedom as opposed to 9 weeks for Angelika. While this does not affect the main European market, where crops are required for mid November, in the UK the traditional Poinsettia sales period is mid December. The increased period of storage prior to harvest under day neutral conditions has led to production problems such as bract blackening (calcium deficiency of the bract) and cyathia drop. Delayed initiation by using night break lighting (NBL) can help to allow scheduling of crops for later markets (December) as shown in the 1992 trial at HRI Efford. However, high humidity can increase the possibility of bract blackening and American trials have indicated that calcium chloride sprays and/or humidity control reduces this problem. Silver thiosulphate (STS), an anti-ethylene compound, has a label recommendation for controlling cyathia drop when applied prior to marketing. There is a questionmark over the future of silver, a heavy metal, and the trialling of other more environmentally efficient flower preservatives should be considered.

3. POTENTIAL BENEFITS TO THE INDUSTRY

The shelf-life of UK produced Poinsettias is a selling point for this crop and any damage to bracts or reduction in shoot number detracts from the market price. Improving plant quality at harvest by the use of techniques such as NBL and DIF, reducing the risk of bract damage and cyathia loss, together with assessing new cultivars is necessary for the continued success of this product in the UK market place.

1992 was a particularly bad year for bract blackening and although it is not easy to assess the likely losses due to poor quality or bract damage a figure of losses per year is estimated notionally at between £150 - 175K. Additional benefits may occur in reduction of labour use both in production and harvesting whilst maintaining quality standards of UK product.

4. SCIENTIFIC/TECHNICAL TARGETS FOR THE WORK

To assess new and existing Poinsettia cultivars for

production in the UK for marketing in December with regard to initiation date, bract quality, flower development and shelf-life. Simulation of high humidities a factor commonly associated with bract blackening will also be considered, including potential remedial spraying of calcium chloride to avoid bract blackening. To evaluate the use of flower preservatives to avoid cyathia drop.

5. CLOSELY RELATED WORK

HRI Efford : PC71 using NBL to delay flower initiation to schedule crops for the December market and to monitor the influence on shelf-life. PC45 and PC80 using anti-ethylene compounds to improve shelf-life of pot plants.

HRI Littlehampton: PC6 The Effect of high humidity on the growth and development of Poinsettia.

USA: Michigan State and Massachusetts Universities work on using Calcium sprays to prevent bract blackening. This needs testing under UK conditions.

Europe: German and Dutch work on bract edge necrosis in Poinsettias is targeting at crops for mid November and this needs looking at in detail for the later UK market.

6. DESCRIPTION OF THE WORK

A. HRI Efford:

Cultivars	-	Red Sails	Freedom
		Peterstar	Lilo
		Fireking	Ria (new Steffi)

Treatments -

Initiation/humidification treatments:

1. Natural season initiation with ambient humidity on ebb and flood floors.
2. Initiation delayed by 10 days with night break lighting of 4 hours from pinching with ambient humidity on ebb and flood floors.
3. Initiation delayed by 20 days with night break lighting of 4 hours from pinching with ambient humidity on ebb and flood floors.
4. Natural season initiation with humidification to 95% RH from bract colouring on ebb and flood floors.
5. Natural season initiation with ambient humidity on benches.

6. Natural season initiation with humidification to 95% RH from bract colouring on benches.

Shelf-life treatments:

Calcium chloride sprays applied every two days and every week from bract colouring to harvest in the natural season treatments with and without humidification.

Additional Observation:

Flower preservatives to reduce cyathia drop applied prior to marketing:

Untreated control

STS

+ other non-silver ethylene inhibiting compounds.

Design:

Unreplicated trial with the main plots of humidity and lighting in 6 compartments in K-block.

Blocks of each variety within the compartments will be in the same geographic location: Each varietal block will consist of 60 plants/compartment.

Culture:

4°C DIF drop for 2 hours from sunrise.
Standard PGR regime.

Records:

1. Crop diary.
2. Initiation assessment - separate observation and examination of ~~each variety~~ carried out by HRI Littlehampton. *RIGHT VARIETALS* *R.S.G.*
3. P & D assessments plus physiological damage to foliage/bract development.
4. Harvesting: Final growth and quality assessments.
5. Shelf-life and transportation damage assessment.
6. Leaf analysis for calcium.

B. Commercial Nurseries

Commercial trialling on a range of cultivars on two nurseries.

Proposed cultivars:	Red Sails	Freedom
	Peterstar	Lilo
	Fireking	Ria (new Steffi)
	Menorca	Ibiza
	Gladys	Glenda
	Francesca	

7. COMMENCEMENT DATE AND DURATION

Start date 01.08.93; duration 10 months. The final report will be produced by May 1994.

8. STAFF RESPONSIBILITIES

Project Leader:	Lionel Sach	HRI Efford
Additional staff:	Harry Kitchener	ADAS Pot Plant Consultant, Cambridge RO.

9. LOCATION

HRI Efford, Lymington, Hampshire and two commercial nurseries in Hampshire and Kent.

Contract No: PC71a

TERMS AND CONDITIONS

The Council's standard terms and conditions of contract shall apply.

Signed for the Contractor(s) Signature..... *[Handwritten Signature]*
 Position..... *Commercial & Marketing Manager HR1*
 Date..... *23/9/93*

Signed for the Contractor(s) Signature.....
 Position.....
 Date.....

Signed for the Council Signature..... *[Handwritten Signature]*
 Position..... CHIEF EXECUTIVE
 Date..... *15.9.93*