HORTICULTURE RESEARCH INTERNATIONAL
EFFORD

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FINAL CONTRACT REPORT

Rieger Begonias: Investigation into cultural factors causing leaf necrosis

HDC PC46 and 46a

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Rieger Begonias: Investigation into cultural factors causing leaf necrosis

HDC PC46a
1994

FINAL REPORT DECEMBER 1995

HDC PC46a

Mr L P H Sach
HRI Efford

Mr A K Fuller
HRI Efford

Co-ordinator: Mr P Hill

Commenced: February 1994

Completed: September 1994

Key words: Rieger Begonia, *Begonia elatior*, necrosis

PRINCIPAL WORKERS

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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 ..D J Hand.....

Dr David J Hand
Head of Protected Crops

Date ..10.12.95....

Report authorised by ....
Signature

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Date 9.12.95

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CONTENTS

Appendices

RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

APPLICATION

The aim of this study was to examine the cultural factors which cause leaf necrosis and develop potential remedies which could be used by growers.

Five cultivars of Rieger Begonia were grown under either a *stressed* environment or as per normal commercial practice (*standard*). No definite 'link' was established between cultural practices and the incidence of leaf necrosis. However, sudden changes in relative humidity in the immediate plant environment were associated with increased levels of leaf necrosis. Such changes were caused during plant spacing, infrequent irrigations and with the use of low level non/permeable blackout materials. These cultural practices can hasten the severity of leaf necrosis but are not thought to be its cause. Cutting material sourced from Denmark was significantly more prone to leaf necrosis than material sourced from the Netherlands. Growing media and leaf tissue analysis identified differences in media pH, manganese and iron levels in the leaf tissue, between plants showing symptoms and those which remained healthy. Increased iron and/or manganese levels in the leaf tissue became associated with plants showing leaf necrosis.

SUMMARY

In 1994, the HDC commissioned a project PC 46a Rieger Begonias: Investigation into the cultural factors which cause leaf necrosis to enable regimes to be developed which can eradicate this plant quality problem.

The objective of the project was to determine the factors which induce leaf necrosis so that potential remedies could be sought. The trial was designed to run throughout the season with a *'standard'* and *'stressed'* growing environment which aimed to induce leaf necrosis symptoms. Fortnightly plantings of Dutch and Danish plant material were made of five Rieger Begonia cultivars which had been selected as being particularly prone to leaf necrosis. From the first planting in week six until the final planting in week twenty two, detailed records were taken every two weeks until marketing to identify the incidence and development of leaf necrosis.

Start Material

Plants were supplied from two propagation sources;

i. Royal Eveleens, Aalsmeer, Netherlands.

ii. GASA Odense, Denmark.

Plants were delivered as rooted 'top' cuttings in 5 cm plastic net pots at fortnightly intervals from week 6 until week 22, 1994, a total of nine sendings.

Cultivars

Begonia elatior Annebell
Begonia elatior Netja
Begonia elatior Jytte
Begonia elatior Camilla
Begonia elatior Britt

(all Ilona types/double flowering)

Treatments

Standard/Control	*Stressed*
● Woven fleece placed over cuttings for 2 weeks from potting.	● No use of woven fleece.
● Throughout cropping maintain humidity above 75%.	● Humidities allowed to fluctuate in line with ambient conditions.
● Half space plants 3 weeks after potting during the winter period.	● No half spacing.
● Final space plants after 5 weeks during the winter period.	● Final space plants after 3 weeks during the summer period and winter period.
● Final space plants after 4 weeks during the summer period and cover with woven fleece for 5 days.	● Plants were not covered with woven fleece after final spacing.
● From potting plants receive 2 weeks of long days followed by 2 weeks of short days and subsequently long days.	● From potting plants to receive 2 weeks of long days followed by 2 weeks short days and subsequently long days.

As an observation a number of plants from both the *standard* and *stressed* compartments did not receive short days.

N.B Winter period = planting week 6 until week 12
Summer period = planting week 14 onwards.

Results

Leaf necrosis was recorded in both the *standard* and *stressed* growing environments. Although the incidence of leaf necrosis was common to both growing environments, levels of leaf necrosis were slightly higher in the *stressed* environment.

The level of leaf necrosis was higher on the cultivar Britt from both propagation sources, although all cultivars in the trial were susceptible.

Danish (GASA Odense) plant material developed significantly higher levels of leaf necrosis in comparison to cuttings purchased from the Netherlands (Royal Eveleens).

Analysis of the propagation media and leaf tissue of the cuttings received identified lower pH levels and significantly higher levels of ammonium-nitrogen in the cuttings received from Denmark; pH was 5.4 as opposed to pH 6.0, and levels of ammonium-nitrogen were 51 mg/l as opposed to 6 mg/l.

Symptoms of leaf necrosis were first recorded 2 weeks after potting. Levels of leaf necrosis increased with time, although the increase in the later production stages (week 8-week 10) was minimal.

Leaf necrosis was common to all plantings although from week 16 (18 April) levels generally decreased.

Conclusion

Cultural practices can influence the severity, or level, of leaf necrosis in production. The precise cause of leaf necrosis however remains unclear, but the propagation source/method can effect the incidence of leaf necrosis in production.

Cultural practices which give rise to rapid fluctuations in humidity should be avoided, although there was no conclusive evidence that the use of fleece or intermediate plant spacing influenced the level of leaf necrosis.

Nutrition appears to play an important role in the cause of leaf necrosis and research conducted in Denmark suggests avoiding the use of ammonium forms of nitrogen fertiliser and ensuring that the growing media pH does not drop below pH 5.8. A low pH in effect will facilitate the uptake of iron/manganese.

As the incidence of leaf necrosis has diminished over the past few years, no further research is currently in progress, although it is evident that further studies are required to understand fully the underlying mechanisms which cause leaf necrosis. Once this is established more accurate control strategies could be developed and adopted.

EXPERIMENTAL SECTION

INTRODUCTION

Rieger Begonias are grown on an all year round basis and are one of the most popular flowering potted plants on the UK market. Over 3.5 million plants are grown in the UK per annum (MAFF Statistics, 1994).

Rieger Begonia production spans approximately a ten week period from potting until sale. Plants are usually supplied as rooted 'top' or 'leaf' cuttings in a 5 cm plastic net pot, or more recently as a 5 cm peat pot. Standard final pot size is 13 cm, although larger or smaller specimens are grown. Rieger Begonias are facultative short day flowering plants with a critical daylength of 13.5 hours. Flowering is advanced and more uniform under short days. Therefore, growers use a combination of daylength extension with artificial lighting and blackout materials to artificially shorten daylength to promote and control plant growth to a certain extent. Growth regulation through chlormequat sprays is also possible to maximise final plant quality.

The plant quality problem 'leaf necrosis' was first considered to be a problem commercially during the early 1990's. The symptoms appear as necrotic veining on the lower, 'mother', leaves at the base of the plant. Severity can range from slight, whereby there is no effect on a plants value, to severe whereby the plant is rendered unmarketable. In Appendix XII on pages 49-51, plates 1, 2, 3 and 4 show the characteristic symptoms of leaf necrosis and how their development can cause considerable loss in plant quality and value. The extent of the problem tends to vary between batches of plants but it is estimated up to 20% of plants from any one batch are affected. The cause of leaf necrosis on Rieger Begonias is not clearly understood, but was thought to be associated with plant stress. Leaf scorch and leaf blister can commonly occur under periods of high light intensity, during the summer period. However, although leaf necrosis developed during the summer period, its incidence varied and it can occur at other times in the production cycle.

Prior to this study there had been no research conducted in the UK as to the cause or prevention of leaf necrosis in Rieger Begonia. Therefore, in 1993 at HRI Efford the Horticultural Development Council (hereafter referred to as the HDC) funded the first of two investigations into the causes of leaf necrosis and examine the use of cultural practices which could be employed by growers to reduce or eliminate the problem.

In 1993 at HRI Efford as part of a MAFF research programme to develop energy efficient systems for crop production, the HDC funded a trial to specifically examine the effect of glasshouse shading and humidification on the incidence of leaf necrosis in Rieger Begonia. This HDC project, PC 46 titled Pot Plants: Summer shading and humidification ran for one year, 1993. This project is outlined in Appendix I, page 23. The results from this trial were inconclusive. The outside solar radiation levels during the summer period in this year were below average and consequently no leaf necrosis was recorded in the unshaded/unhumidified compartment. In addition, it was also noticed by growers in the same year that leaf necrosis continued to develop on certain plant batches, but no common causal factor could be identified.

In 1994, the HDC commissioned a second project PC 46a Rieger Begonias: Investigation into the cultural factors which cause leaf necrosis to enable regimes to be developed which can eradicate this plant quality problem.

The objective of the project was to determine the factors which induce leaf necrosis so that potential remedies could be sought. The trial was designed to run throughout the season with a *'standard'* and *'stressed'* growing environment which aimed to induce leaf necrosis symptoms. Fortnightly plantings of Dutch and Danish plant material were made of five Rieger Begonia cultivars which had been selected as being particularly prone to leaf necrosis. From the first planting in week six until the final planting in week twenty two, detailed records were taken every two weeks until marketing to identify the incidence and development of leaf necrosis symptoms. With the use of a far larger proportion of the production period it would be more likely that leaf necrosis could be induced this way rather than targeting one single period of the year as in the 1993 trial.

OBJECTIVES

1. To identify the factors which induce leaf necrosis in Rieger Begonias.

2. To determine potential cultural treatments which can be used to alleviate the onset of such damage throughout the production period.

3. To develop a greater understanding of the cultural requirements for the successful production of Rieger Begonias.

MATERIALS AND METHODS - PC 46a 1994

Site

Plants were potted immediately upon receipt and grown on in two compartments of the multifactorial glasshouse, K Block at HRI Efford. Up to three batches of plants were in one compartment at the same time. A Crop Schedule is shown for each compartment in Appendix II, pages 24 and 25. Plants were grown on benches with capillary matting and watered from below after an initial watering in overhead.

Start Material

Plants were supplied from two propagation sources;

i. Royal Eveleens, Aalsmeer, Netherlands.

ii. GASA Odense, Denmark.

Plants were delivered as rooted 'top' cuttings in 5 cm plastic net pots at fortnightly intervals from week 6 until week 22, 1994, a total of nine sendings.

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● From potting plants receive 2 weeks of long days followed by 2 weeks of short days and subsequently long days.	● From potting plants to receive 2 weeks of long days followed by 2 weeks short days and subsequently long days.

As an observation a number of plants from both the *standard* and *stressed* compartments did not receive short days.

N.B Winter period = planting week 6 until week 12
Summer period = planting week 14 onwards.

Experimental design

Replicated trial with the main plots in two benched compartments in K Block.

Blocks of each variety within each compartment were in the same geographical location througout the trial period.

2	cultural growth treatments (*standard* vs *stressed*)
x	
2	replicates
--	
4	plots/species
x	
5	varieties
--	
20	plots
x	
9	potting dates
--	
180	plots

Plot size: 20 plants in each varietal block of which the middle 10 plants were recorded.

Cultural Details

The rooted cuttings were potted in to 13C terracotta pots using Finn Peat VAPO B3 growing media. Analysis of growing media at potting is given in Appendix VII , page 42 . The plants were then moved to their respective compartment/treatment. Plants were grown on benches with capillary matting and after an initial watering in plants were irrigated from below.

Temperature: all plants were grown on with a heating temperature set point of 20°C day/night with a vent set point of 22°C day/night throughout the trial period.

Carbon dioxide: both treatment compartments were enriched using pure CO_2 to maintain a level of 500ppm, and 750ppm on bright days.

Humidity: there was no direct humidity control other than ensuring compartment floors and benches were 'damped down' regularly to maintain a minimum relative humidity of 75% in the *standard* compartment, whilst no 'damping down' was carried out in the *stressed* compartment in which the humidity was allowed to follow ambient conditions between irrigations.

Irrigation: plants were watered from below by hand onto the capillary matting. The plants in the *stressed* compartment were allowed to 'dry out' in between irrigations, to the point when the growing media contracted from the pot sides, whilst plants in the *standard* compartment were irrigated frequently to keep the growing media moist at all times.

Daylength manipulation: Plants received long days for two weeks from potting at which point plants were subjected to short days for two weeks after which plants were subsequently grown in long days. Where appropriate natural long/short days were used, but artificial long days were provided for 18 hours per day, 03.00hrs until 21.00hrs, using high pressure sodium lamps (SON/T) at 6W/m². A light threshold of 80W/m² was applied at which point the supplementary lighting was no longer applied. Artificial short days were provided for 11 hours, 07.30hrs until 18.30hrs, with the use of reflective blackout material (AYR chrysanthemum type).

Plant spacing: half spacing was at 33 plants per metre square on a staggered arrangement. Full spacing was at 22 plants per metre square.

Pinching: at one week after potting the growing tip of the plant was removed by gently rubbing the growing tip between thumb and fore finger.

Shading: plants were shaded using a 40% Ludwig Svenssen shading screen set to shade at light levels > 300W/m².

Plant growth regulation: Cycocel (chlormequat at 465g/l) was applied at 0.5ml/l with the addition of 10% PBI non-ionic spreader. Applications were made as seen necessary throughout the cropping period on a variety/block basis.

Nutrition: Liquid feed was applied 3-4 weeks after potting at every watering.

Product	**grammes/litre**	**target**	**ppm**
Ammonium Nitrate	55	N	200
Mono ammonium phosphate	10	P	30
Potassium Nitrate	87	K	160

Stock feed diluted 1:200
Water was adjusted for acidification using nitric acid (40ppm N at pH6.0).

Pest and disease control: biological control agents employed throughout the course of the trial included:

Amblyseius cucumeris	for	Western Flower Thrips
Phytoseiulus persimilis	for	Two Spotted Spider Mite
Aphidius colemani	for	Aphids
Aphidoletes aphidimyza	for	Aphids

No chemical pesticides or fungicides were necessary.

Further details of crop maintenance are given in the Crop Diary shown in Appendix III, page 26.

Assessments

A record of the quality of the cutting material recieved was recorded for each batch of plants. This included observations on the moisture level of the propagation media, cutting uniformity, size, leaf colour, leaf damage, presence of any pest or disease, presence of any leaf necrosis and finally an overall quality score.

Records were taken at 14 days, 28 days, 42 days and at 70 days(marketing) post potting to assess the incidence and level of leaf necrosis present.

- Total number of leaves per plant with leaf necrosis.

A series of growing media and leaf tissue samples were taken througout the duration of the trial period. These included;

- media analysis at potting.
- media and leaf tissue analysis of cutting material received.
- media and leaf tissue analyses between treatments and plants expressing symptoms of leaf necrosis and plants which remained healthy.

Statistical Analysis

Due to the absence of full replication within this experiment the resultant data were not subject to formal statistical analysis.

Grower Survey

In the autumn of 1994 a questionnaire was distrubuted to 12 grower holdings in the UK in an effort to quantify the problem of leaf necrosis present amongst Begonia growers, and to examine if any consistent trends were apparent between grower holdings which would account for the leaf necrosis. Eight growers replied to the questionnaire. An example of the questionnaire is given in Appendix VI, pages 37 to 41.

RESULTS

CUTTING MATERIAL

Observations upon receipt

Slight differences were observed throughout the trial period in terms of leaf colour and cutting size, although these were not thought to be related to the cause of leaf necrosis.

Throughout the trial on both Dutch and Danish material it was observed that root growth was far more active at the top of the net pot. Rooting was more lateral within the growing media, and few roots were visible in the lower areas of the pot.

Propagation Media Analysis

At several points within the trial period samples of the growing media in which the plants had been propagated were taken. Results of these analyses comparing Dutch and Danish plant material are given in Appendix VIII, page 43.

The results for Danish material revealed increased levels of nitrogen in the ammoinical form, whilst the media pH was lower than that found in the Dutch plants, at pH 5.45. Sulphate levels were considerably higher in the Danish media in comparison to the Dutch media.

Leaf Tissue Analysis

At the same time of sampling the media, leaf tissue samples were also taken for analysis. The results showed an increase in leaf potassium levels in Danish plant material in comparison to Dutch leaf material, whilst levels of manganese and iron were lower. The results of the leaf tissue analysis are given in Appendix VIII, page 43.

CULTURAL PRACTICES

Results are presented in graphical form in Appendices IV and V, pages 27-36, and in Appendix XII, plates 5 and 6 show a comparison of plant growth at marketing for the cultivar 'Annebell'.

Effect of standard vs stressed growing regime on leaf necrosis

Although there were no consistent differences in the incidence of leaf necrosis between the two cultural treatments, records at marketing indicated a higher level of leaf necrosis on plants grown in the *stressed* compartment.

Effect of plant material source (Dutch vs Danish) on leaf necrosis

The incidence and level of leaf necrosis was significantly higher on Danish plant material throughout the course of the trial. All cultivars supplied by GASA Odense developed greater levels of leaf necrosis than plant material supplied by Royal Eveleens.

There was minimal leaf necrosis recorded from Dutch plant material. The cultivars Britt and Camilla were recorded as having the highest levels of leaf necrosis.

Effect of 'blackout' on leaf necrosis

There was no significant difference in levels of leaf necrosis between blacked out and non blacked plants from Denmark, although levels of leaf necrosis were slightly higher where blackout had been used on the cultivars recieved from the Netherlands, particularly on the cultivars Jytte and Camilla.

Effect of begonia cultivar on leaf necrosis

All cultivars were susceptible to leaf necrosis.

Leaf necrosis was more severe on the cultivars Jytte and Britt received from Denmark, whereas the cultivars Britt and Camilla were more susceptible where the plant material had originated from the Netherlands.

Effect of potting date on leaf necrosis

Levels of leaf necrosis increased from the first planting in week 6 until week 16, after which point the overall levels of leaf necrosis were seen to decline.

Incidence of leaf necrosis during growth

The number of leaves per plant with leaf necrosis increased over time. There were no symptoms of leaf necrosis upon receipt of the cuttings.

First symptoms were recorded two weeks after potting exclusively on material from Denmark, although the levels were very low at this point. Leaf necrosis developed rapidly on plant material from Denmark, and was significantly higher at marketing.

Plant material from the Netherlands developed symptoms after 4 weeks, and the level increased after 8 weeks and at marketing, although the increase in necrosis between 8 and 10 weeks post potting was not as great as that between 4 and 8 weeks post potting.

Growing media and leaf tissue analyses

Results are given in Appendix IX, Table 4, page 44, which detail both growing media and leaf tissue analyses results comparing healthy plants with plants showing symptoms of leaf necrosis. Plants which were showing symptoms of leaf necrosis had very similar growing media results to plants which appeared healthy. Leaf tissue results identified increased levels of both iron and manganese in plant material which had symptoms of leaf necrosis.

Further growing media and leaf tissue analyses are given in Appendix X, pages 45 and 46.

Table 5.1 details growing media analysis for each cultivar grown under each cultural regime (*standard* or *stressed*). The main difference in analysis is that the pH levels in growing media in which plants were displaying symptoms of leaf necrosis were lower, < pH 5.5. There were no other consistent differences.

Tables 5.2 and 5.3 show results for leaf tissue analysis for two cultivars, Britt and Netja, and a comparison between plants grown in both cultural treatments and those plants with and without leaf necrosis. Leaf tissue analysis showed higher levels of phosphorus, calcium, magnesium, iron and manganese in plants grown under a stressed environment, and levels were highest in plants displaying symptoms of leaf necrosis. In contrast levels of copper were commonly 50% lower in plants displaying symptoms of leaf necrosis.

Grower Survey - results

1. Level of necrosis present.......

   Generally growers reported a reduction in levels of leaf necrosis in 1994, in comparison to the 1993 season. Levels of leaf necrosis in 1993 were seen to be moderate-severe, whereas all nurseries reported slight-moderate levels in 1994.

2. Time of year symptoms were apparent.......

   In 1993 and 1994, leaf necrosis was throughout the main production periods, but was at higher levels during weeks 14-34, the period April to August.

3. Position of leaf necrosis on the plant.......

   The first symptoms were consistently reported on the lower 'mother' leaves.

4. At what point does leaf necrosis appear in the crop.......

   Only occasionally leaf necrosis was recorded on receipt of cutting material. One grower reported leaf necrosis 1-2 weeks after potting, whilst most often leaf necrosis was first noticed between 3-5 weeks after potting, commonly when plants were spaced.

5. Cultivars affected.......

   The following cultivars have been recorded with symptoms of leaf necrosis;

   Camilla*
   Annebell*
   Dark Netja*
   Blenda
   Jytte
   Bella
   Kleo
   Netja

   * = generally seen as being more prone to leaf necrosis.

   N.B Cultivars Barkos and Azotus were not affected.

6. Source of cutting material.......

   The majority of growers used Danish material (only one grower using Dutch).

7. Type of cutting.......

   All growers used top cuttings, with the exception of one grower who uses leaf cuttings.

8. Size of cutting.......

   All growers used 5cm cutting in a net pot (more recently peat pots are used).

Cultural Details

Compost type.......

There were a wide range of growing medias used, including proprietary specialist mixes and 'homemade' mixes. Target pH ranges were pH5.5 - pH6.5.

Nutrition.......

All growers used straight fertilizers for the stock feed solution with a ration of N:K of 1:1. The majority of growers used calcium nitrate in preference to ammonium nitrate.

Irrigation.......

Most growers use a ebb and flow irrigation system, with some growers using capillary matting.

Shading.......

The use of fleece immediately after potting was not used by all growers. Shade screens were set to shade at solar radiation levels $>300W/m^2$, and this threshold was increased to $600W/m^2$ at final spacing.

Spacing.......

All growers adopted a half spacing, and final spacing ranged from 21 plants/m^2 up to 25 plants/m^2.

Blackout.......

The majority of growers used a woven cloth type blackout material. Artificial short days were applied from week 12/14 until week 42.

Supplementary lighting.......

Growers use supplementary lighting from week 42 until week 12 to provide in the region of 2000-2500lux by SON/T sodium lighting.

Chemical Plant Growth Regulators.......

All growers use Chlormequat (Cycocel) with a spreader.

DISCUSSION

The results from this trial suggest that the cause of leaf necrosis lies within the propagation stage, and that the grower receiving plant material can only minimise the risk of expression of the symptoms of leaf necrosis.

Throughout the trial period the incidence or cause of leaf necrosis could not be established. Symptoms of leaf necrosis were commonly recorded from both the *stressed* and *standard* growing environments. The different cultural treatments only influenced the severity or level of leaf necrosis. The source of plant material had the greatest influence on the incidence of leaf necrosis, plant material from Denmark being more prone to leaf necrosis. On examination of the cutting material received from each source there were no apparent visual differences, but analysis of the propagation media identified some particular variants in mineral levels. Higher ammonium forms of nitrogen and a lower pH were found in the propagation media of the plants recieved from Denmark.

The effect of growing plants in a *stressed* environment tended to increase the level of leaf necrosis, although leaf necrosis was also present in the standard growing regime. '*Stressing*' plants through erratic watering caused fluctuations in humidity in the aerial environment. The effect of blackout would possibly have a similar effect in raising/lowering the relative humidity. It did appear within the trial that plants which were not blacked out, and thus were not exposed directly to sudden changes in humidity, were less prone to the development of leaf necrosis.

Although some differences in cultivar response were observed in the trial, all cultivars were susceptible to leaf necrosis.

Records of leaf necrosis over the trial period showed that levels of leaf necrosis increased from the first potting in week 6 until pottings in week 14 and 16, after which point the levels of leaf necrosis were reduced. This period relates closely to the increasing day length and levels of natural solar radiation at this time of year, although no direct link can be made.

It appears that leaf necrosis is closely related to the conditions experienced in propagation, and this particular trial identified significantly higher levels of leaf necrosis where plants had been purchased from Denmark. In contrast, plants purchased from the Netherlands were less likely to suffer from leaf necrosis. Although no conclusive results can be drawn from the treatments applied in this trial they suggest that a number of cultural factors can influence the level of leaf necrosis. Sudden fluctuations in humidity should be avoided. Therefore, care should be afforded to irrigation techniques to ensure watering is even and that plants are not allowed to become over wet or allowed to dry out. The type of material used for blackout material should be one which permits air exchange and thus discourages sudden changes in humidity.

From the growing media and leaf tissue analysis it appeared that increased levels of iron and/or managese in the leaf tissue were associated with plants showing symptoms of leaf necrosis. Similarly, it appeared that nutrition could have an impact on leaf necrosis, specifically pH and ammonium levels. Research work in Denmark has examined fertilizer effects on leaf necrosis and the results indicate there may be a link, and that high levels of ammonium fertilisers should be avoided which would potentially lower the propagation media pH facilitating both mineral iron/manganese uptake.

In summary, this trial suggests that the incidence of leaf necrosis seen during production is caused by factors applied in the propagation stage. As such growers are therefore reliant upon methods of propagation for the final plant quality in production, including the incidence of leaf necrosis.

CONCLUSION

Within this trial, the level of leaf necrosis was significantly different between the two sources of plant material, with far higher levels appearing in the cultivars received from Denmark (GASA Odense).

Although levels of leaf necrosis were not consistent between treatments over the trial period, there was an indication that changes within the immediate plant environment would affect the severity of leaf necrosis. Sudden changes in humidity are to be avoided. There was no conclusive evidence that the use of fleece or the imposition of intermediate spacings influenced the incidence or level of leaf necrosis.

It is expected that levels of leaf necrosis will be higher in the earlier part of the year as day length and natural solar radiation increases.

The role of nutrition and its effect on leaf necrosis is not fully understood, but it appears from initial observations in this trial that nutrition could have an important role to play in the incidence of leaf necrosis. Results from Danish research suggest that the growing media pH should not be allowed to drop below pH 5.8, whilst ammonium forms of nitrogen fertiliser should be reduced or replaced with an alternative nitrogen source, for example, calcium nitrate.

As the incidence of leaf necrosis has diminished over the past few years, no further research is currently in progress, although it is evident that further studies are required to understand fully the underlying mechanisms which cause leaf necrosis. Once this is established more accurate control strategies could be developed and adopted.

APPENDICES

APPENDIX I

PC 46 - Rieger Begonias: Summer shading and humidification 1993.

Description of the work

Within the combined MAFF and HDC project the following treatments were examined;

(a) Shading at 600W/m^2 with humidification.

(b) Shading at 600W/m^2 without humidification.

(c) Shading at 450W/m^2 with humidfication.

(d) Shading at 450W/m^2 without humidification.

(e) Shading at 300W/m^2 with humidification.

(f) Shading at 300W/m^2 without humidification.

Shading using LS 15 Ludvig Svensson screen material.

Humidification triggered in response to high glasshouse air temperature.

Treatments commenced 3 weeks after potting.

A range of cultivars of Rieger Begonia were included;

Cultivar	**Type**	**Cultivar**	**Type**
Jytte	Ilona	Netja	Ilona
Kathleen	Ilona	Lone	Aphrodite
Louise	Ilona	Focus	Aphrodite
Line	Ilona	Anja	Rosalie
Annebell	Ilona	Paloma	Rosalie
Ilona	Ilona	Desiree	Rosalie

Assessments

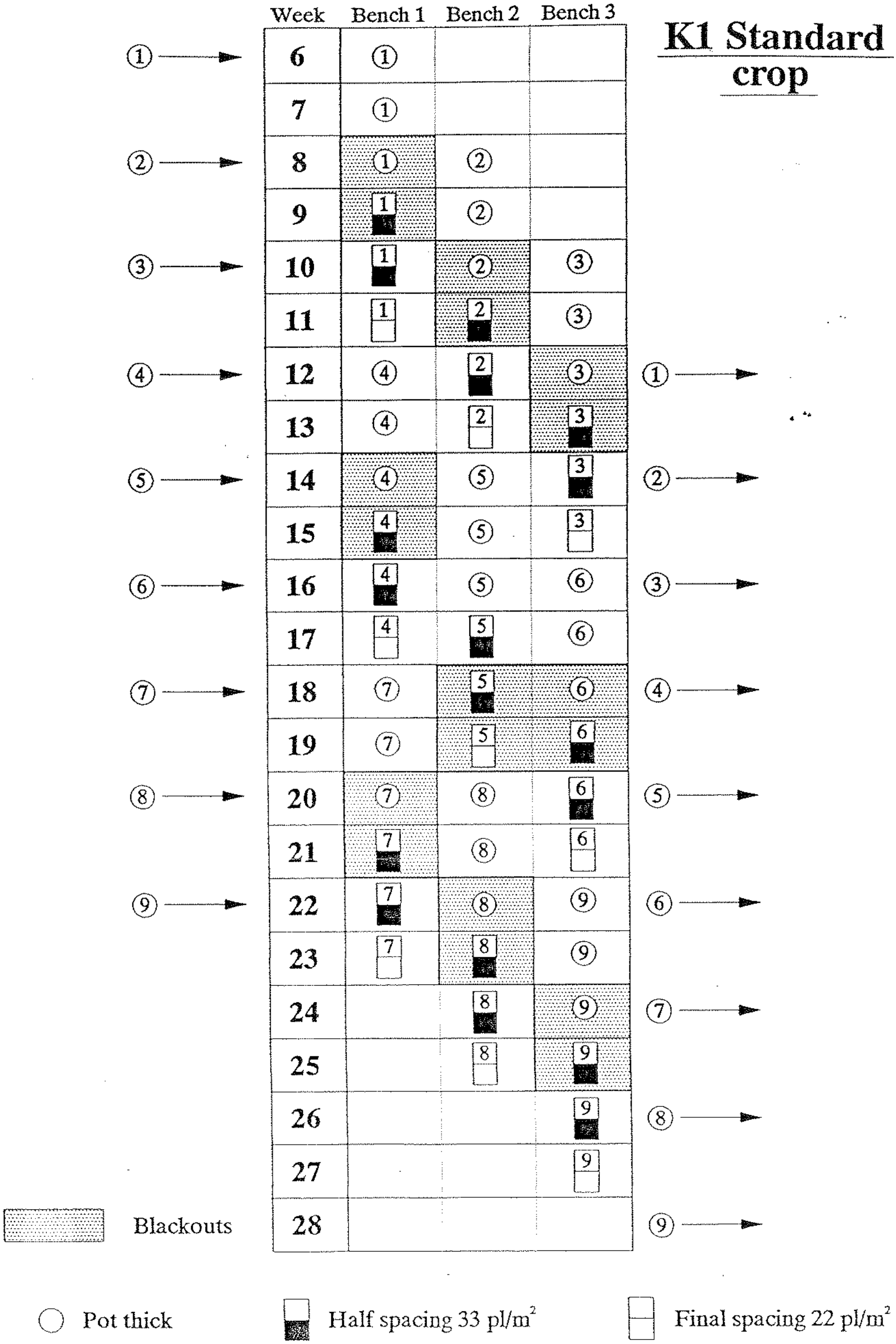
Plant growth measurements were recorded at marketing which included an assessment for the presence or absence of leaf necrosis.

Results

No symptoms of leaf necrosis were recorded as part of this trial.

HDC PC 46a - Reiger Begonia 1994 crop schedule

K1 Standard crop



	Week	Bench 1	Bench 2	Bench 3	
① →	6	①			
	7	①			
② →	8	▨ ①	②		
	9	▨ 1 ■	②		
③ →	10	1 ■	▨ ②	③	
	11	1 □	▨ 2 ■	③	
④ →	12	④	2 ■	▨ ③	① →
	13	④	2 □	▨ 3 ■	
⑤ →	14	▨ ④	⑤	3 ■	② →
	15	▨ 4 ■	⑤	3 □	
⑥ →	16	4 ■	⑤	⑥	③ →
	17	4 □	5 ■	⑥	
⑦ →	18	⑦	▨ 5 ■	▨ ⑥	④ →
	19	⑦	▨ 5 □	▨ 6 ■	
⑧ →	20	▨ ⑦	⑧	6 ■	⑤ →
	21	▨ 7 ■	⑧	6 □	
⑨ →	22	7 ■	▨ ⑧	⑨	⑥ →
	23	7 □	▨ 8 ■	⑨	
	24		8 ■	▨ ⑨	⑦ →
	25		8 □	▨ 9 ■	
	26			9 ■	⑧ →
	27			9 □	
	28				⑨ →

▨ Blackouts

○ Pot thick

■ Half spacing 33 pl/m²

□ Final spacing 22 pl/m²

Figure 2

HDC PC 46a - Reiger Begonia 1994 crop schedule

K8 Stressed crop

	Week	Bench 1	Bench 2	Bench 3	
① →	6	①			
	7	①			
② →	8	▨ ①	②		
	9	▨ $\boxed{1}$	②		
③ →	10	$\boxed{1}$	▨ ②	③	
	11	$\boxed{1}$	▨ $\boxed{2}$	③	
④ →	12	④	$\boxed{2}$	▨ ③	① →
	13	④	$\boxed{2}$	▨ $\boxed{3}$	
⑤ →	14	▨ ④	⑤	$\boxed{3}$	② →
	15	▨ $\boxed{4}$	⑤	$\boxed{3}$	
⑥ →	16	$\boxed{4}$	⑤	⑥	③ →
	17	$\boxed{4}$	$\boxed{5}$	⑥	
⑦ →	18	⑦	▨ $\boxed{5}$	▨ ⑥	④ →
	19	⑦	▨ $\boxed{5}$	▨ $\boxed{6}$	
⑧ →	20	▨ ⑦	⑧	$\boxed{6}$	⑤ →
	21	▨ $\boxed{7}$	⑧	$\boxed{6}$	
⑨ →	22	$\boxed{7}$	▨ ⑧	⑨	⑥ →
	23	$\boxed{7}$	▨ $\boxed{8}$	⑨	
	24		$\boxed{8}$	▨ ⑨	⑦ →
	25		$\boxed{8}$	▨ $\boxed{9}$	
	26			$\boxed{9}$	⑧ →
	27			$\boxed{9}$	
	28				⑨ →

▨ Blackouts

○ Pot thick

⊟ Final spacing 22 pl/m^2

APPENDIX III

Table 1 Crop Diary

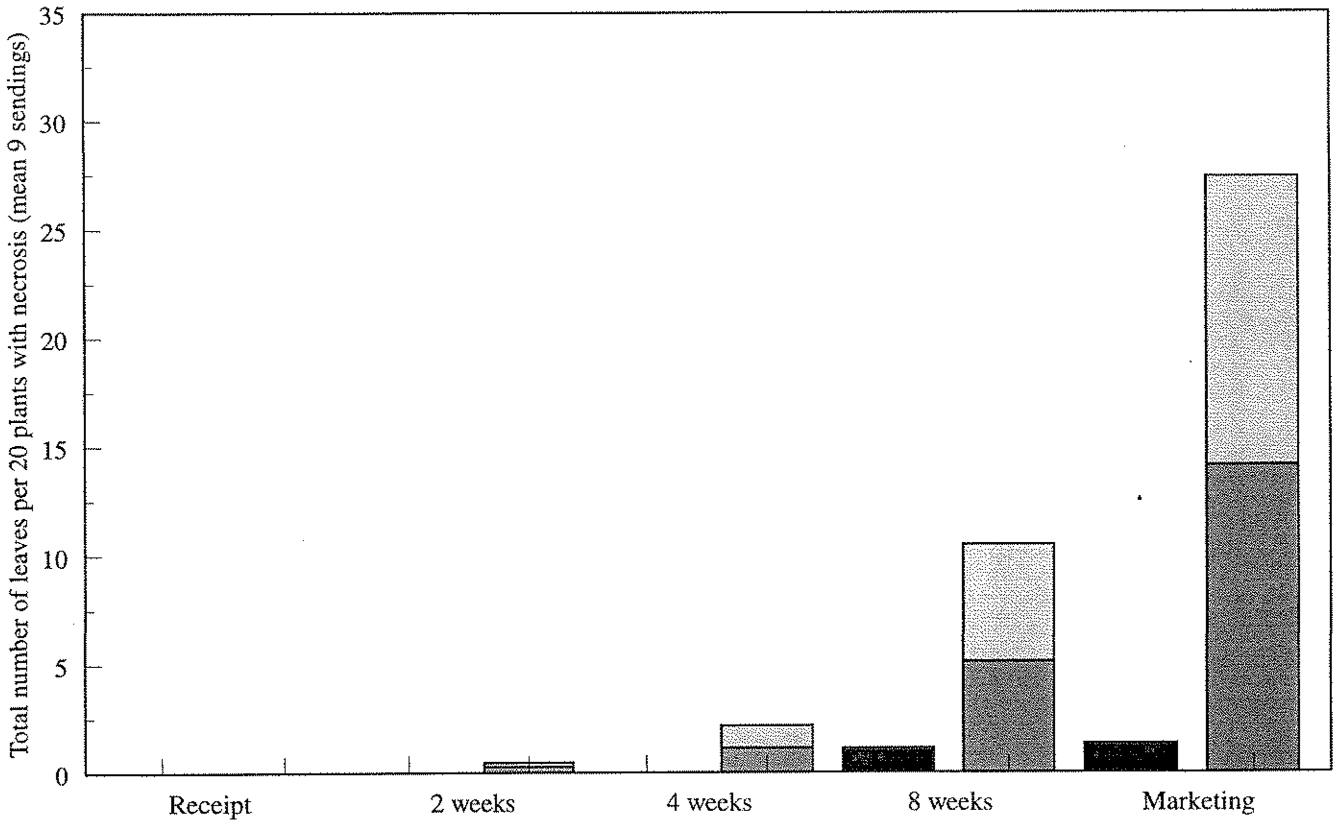
	Planting								
	1	2	3	4	5	6	7	8	9
Operation									
Potted	11.02	25.02	11.03	26.07	13.04	22.04	05.05	20.05	03.06
Pinched	01.03	04.03	16.03	31.03	19.04	29.04	12.05	24.05	07.06
Half Space	04.03	07.03	29.03	-	-	-	-	-	-
Full Space	17.03	28.03	15.04	15.04	26.04	30.05	25.05	08.06	27.06
Cycocel (1st application)	08.03	08.03	18.03	02.04	22.04	03.06	16.05	03.06	10.06
Cycocel (2nd application)	-	-	29.03	-	26.05	-	21.06	01.07	-
Marketing	21.04	05.05	19.05	02.06	16.06	30.06	14.07	28.07	11.08

APPENDIX IV

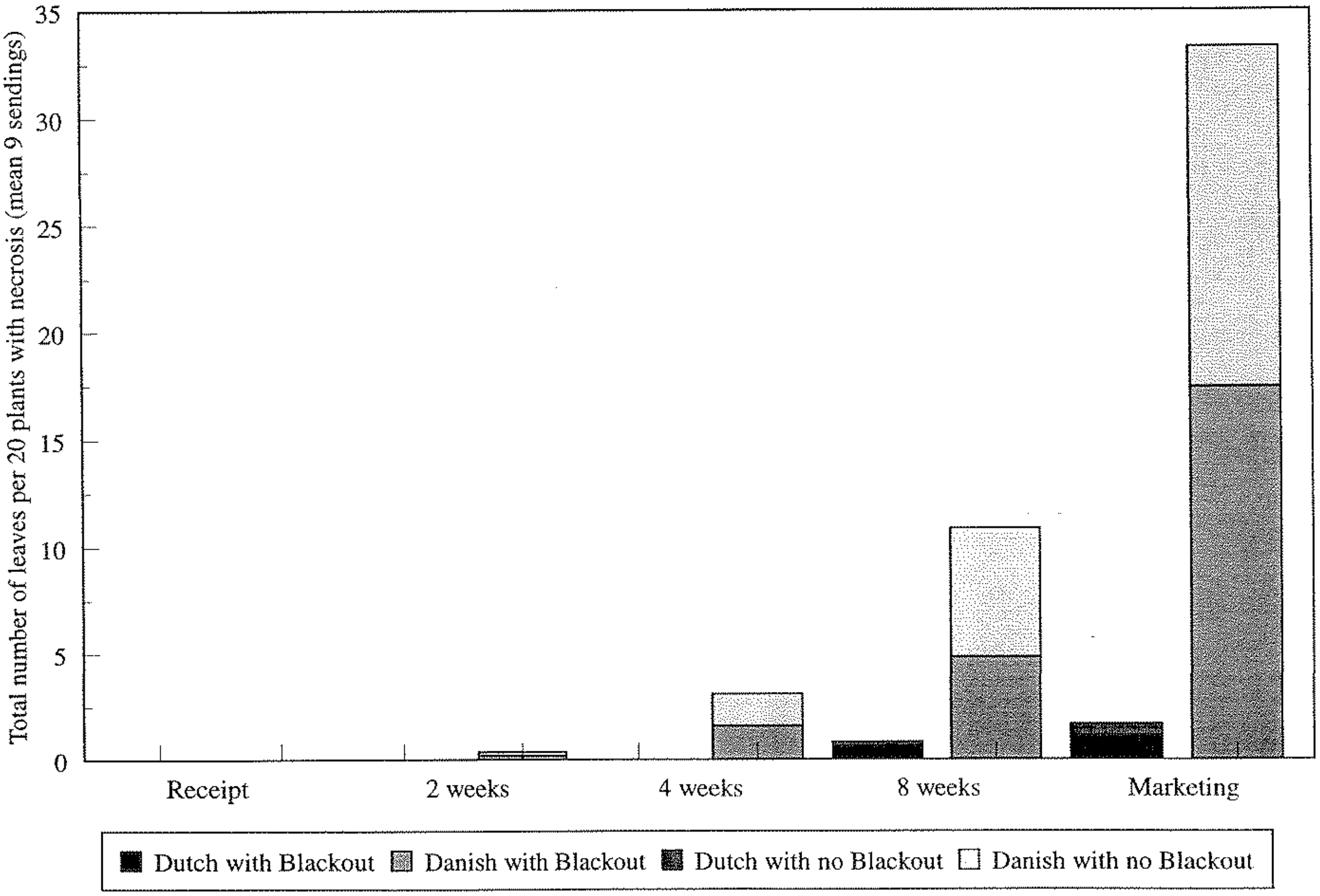
Figure 3.1

Effect of cultural regime and source of material on the level of leaf necrosis - during growth

Standard Regime - Cultivar 'Jytte'



Stressed Regime - Cultivar 'Jytte'

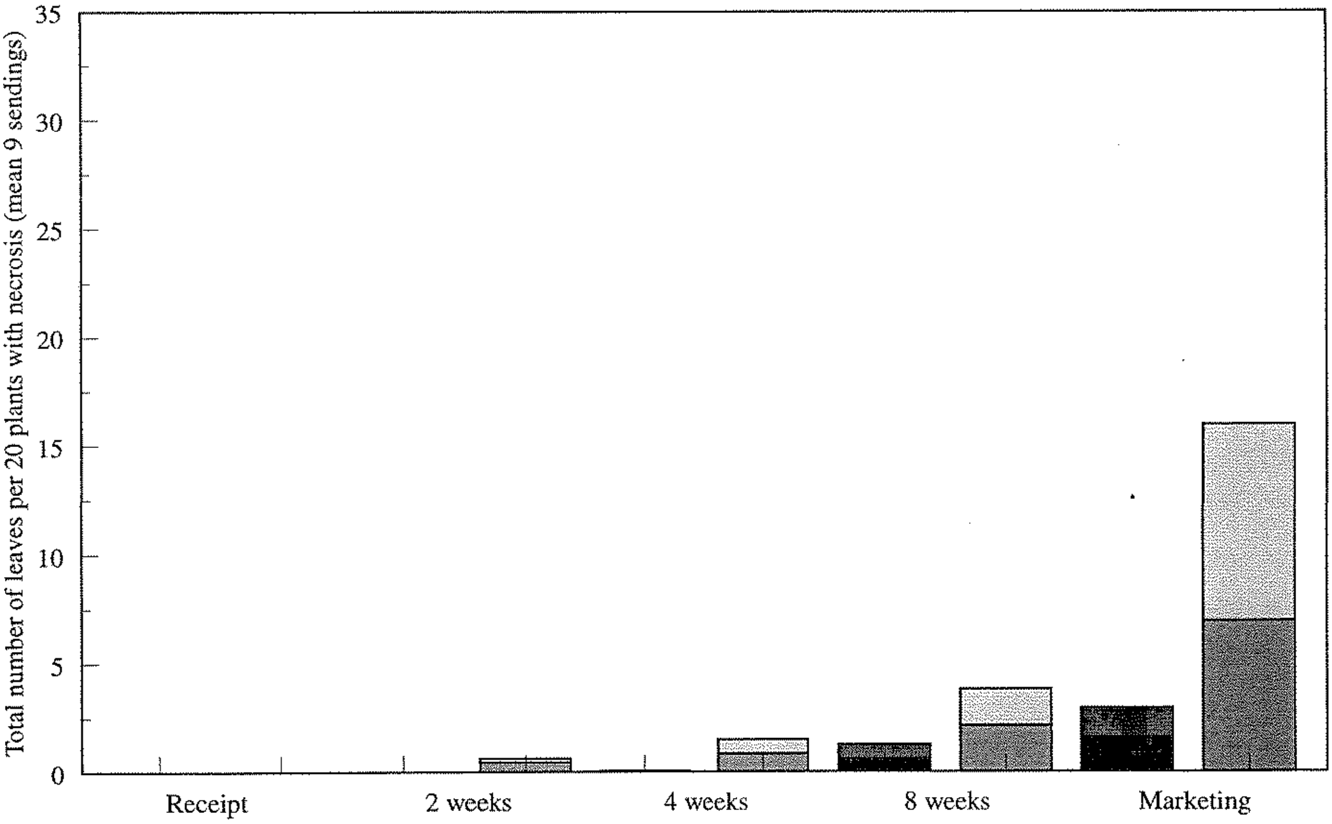


APPENDIX IV

Figure 3.2

Effect of cultural regime and source of material on the level of leaf necrosis - during growth

Standard Regime - Cultivar 'Netja'



Stressed Regime - Cultivar 'Netja'

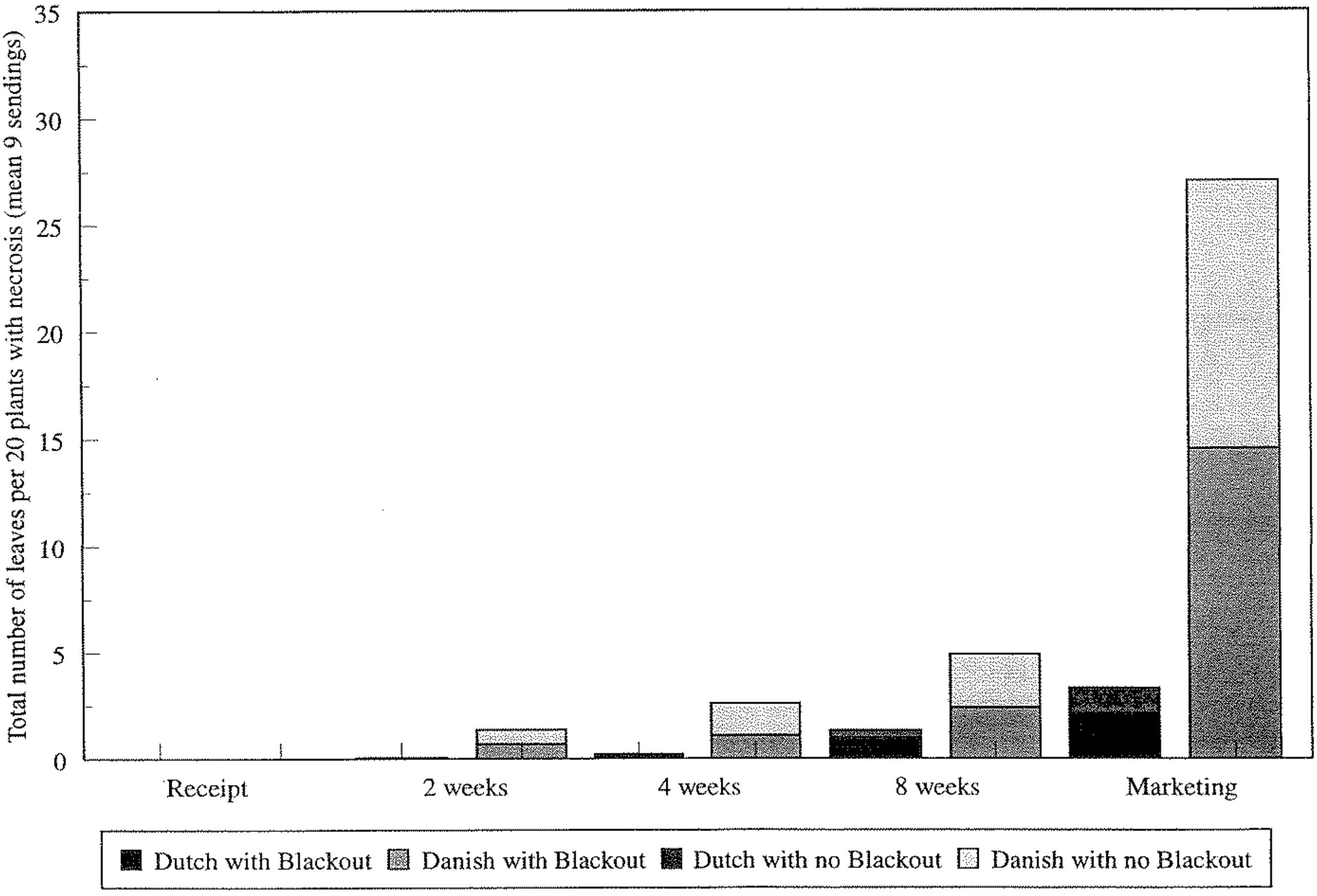
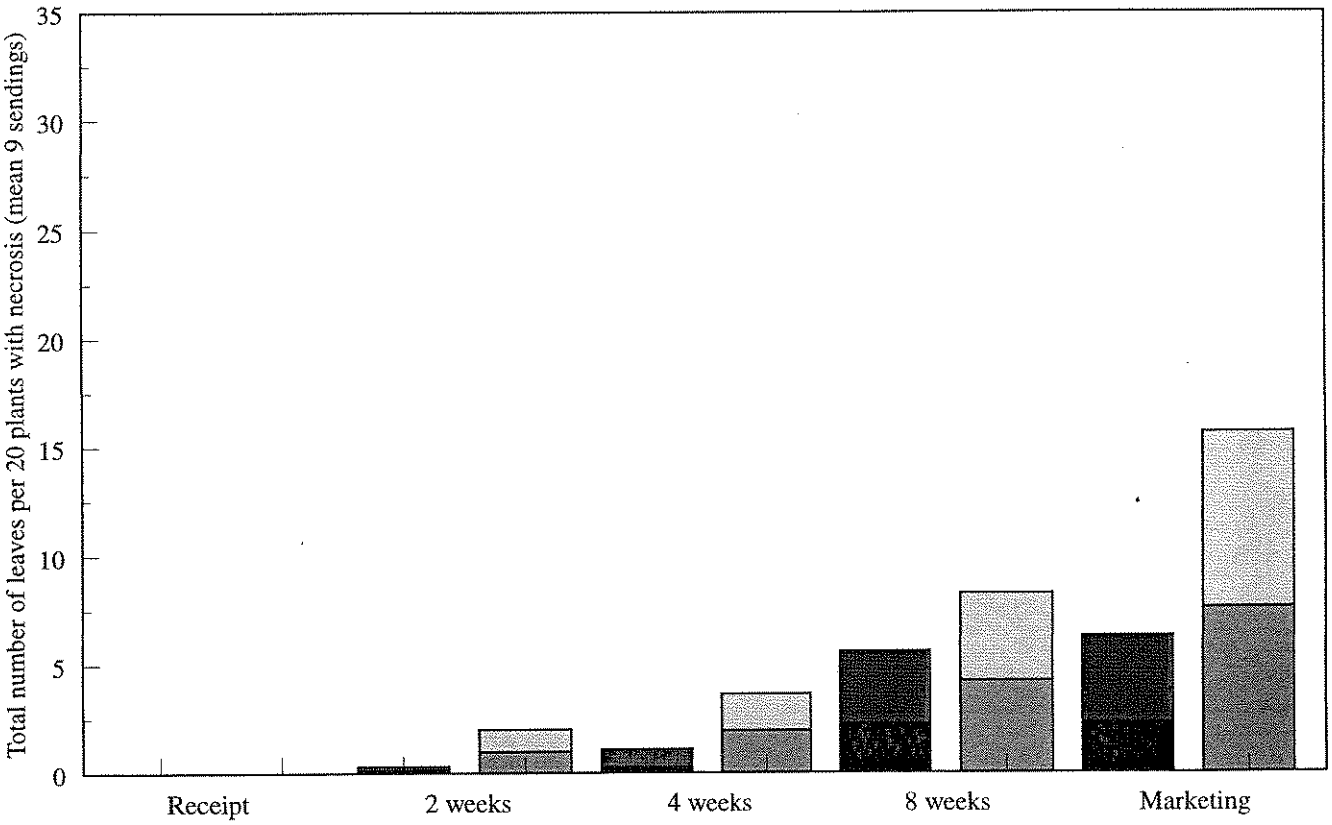


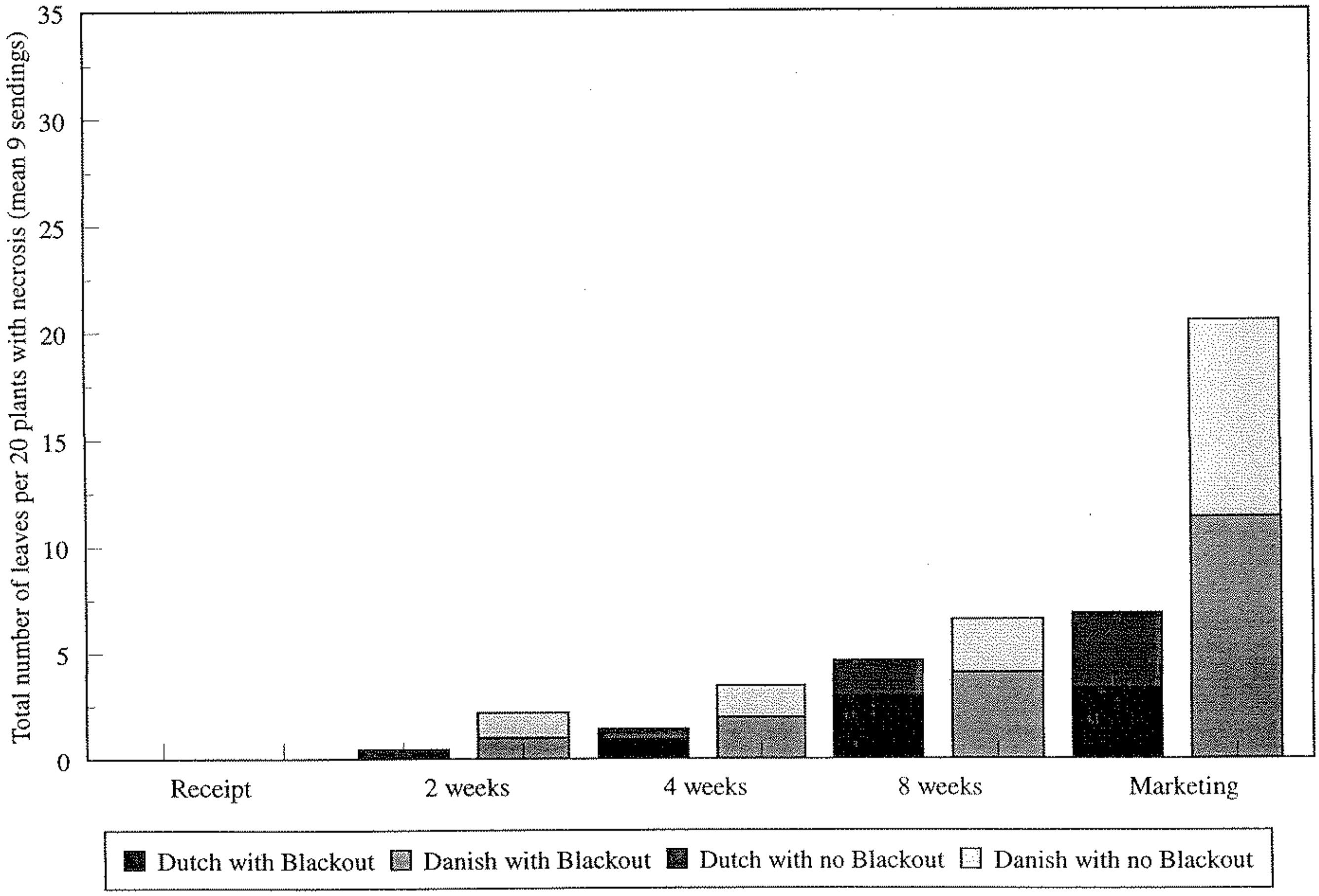
Figure 3.3

Effect of cultural regime and source of material on the level of leaf necrosis - during growth

Standard Regime - Cultivar 'Britt'



Stressed Regime - Cultivar 'Britt'

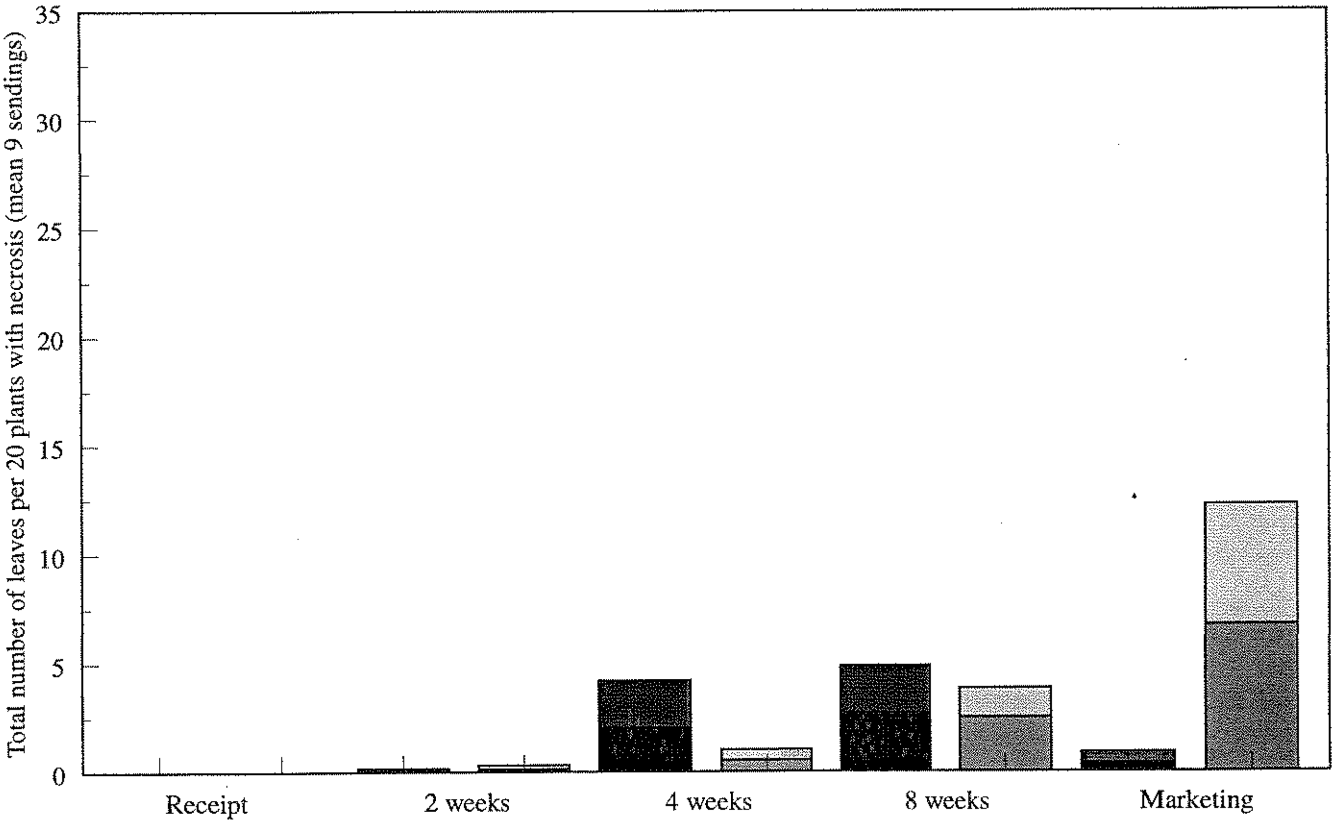


APPENDIX IV

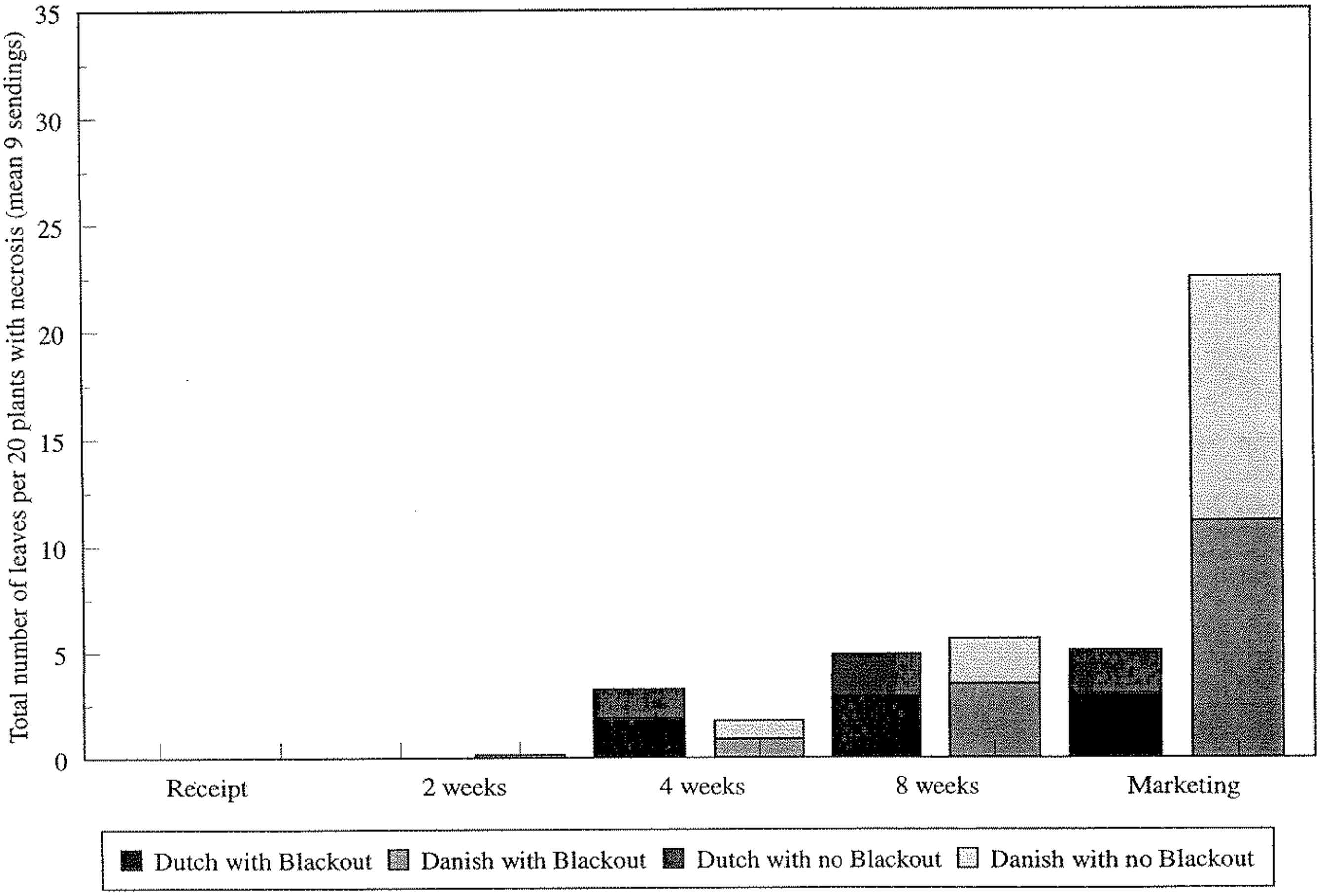
Figure 3.4

Effect of cultural regime and source of material on the level of leaf necrosis - during growth

Standard Regime - Cultivar 'Camilla'



Stressed Regime - Cultivar 'Camilla'

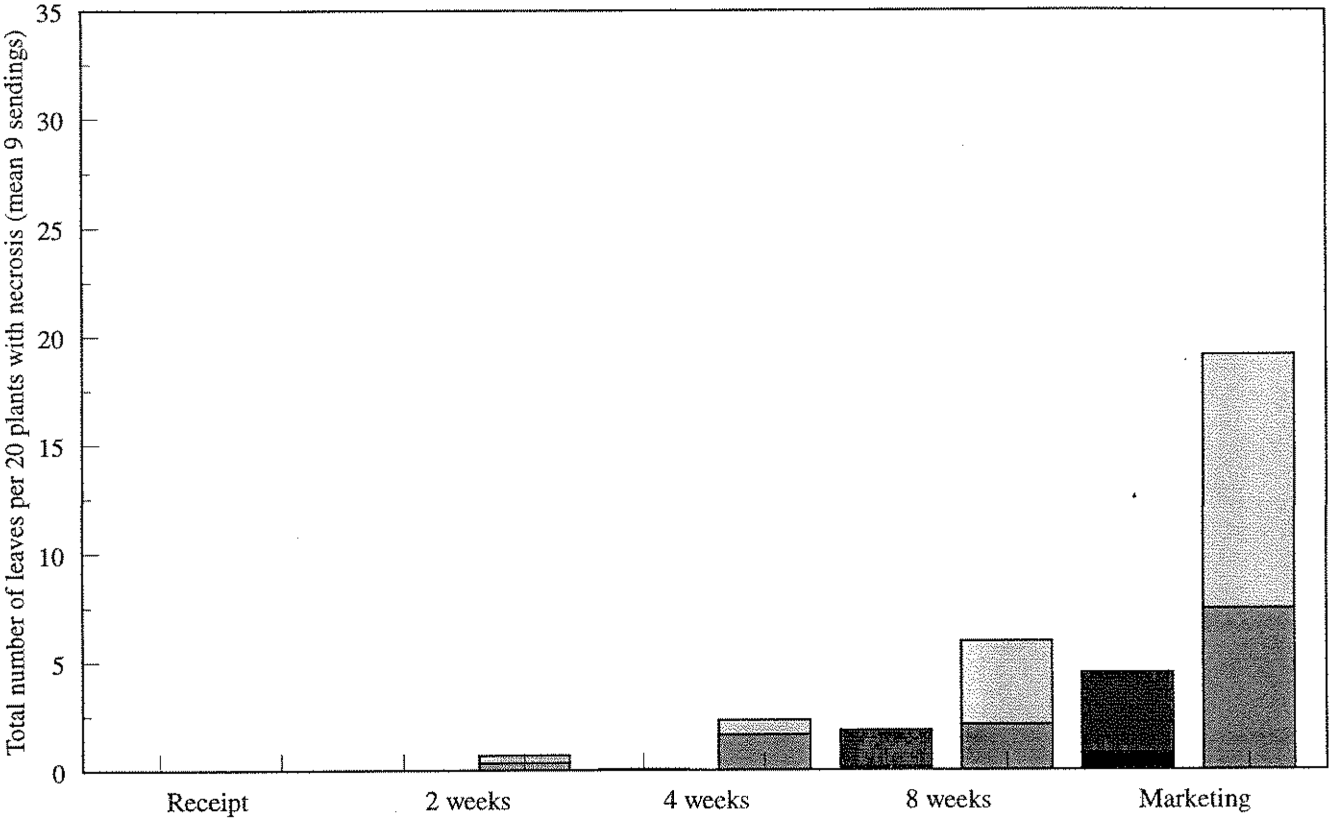


APPENDIX IV

Figure 3.5

Effect of cultural regime and source of material on the level of leaf necrosis - during growth

Standard Regime - Cultivar 'Annebell'



Stressed Regime - Cultivar 'Annebell'

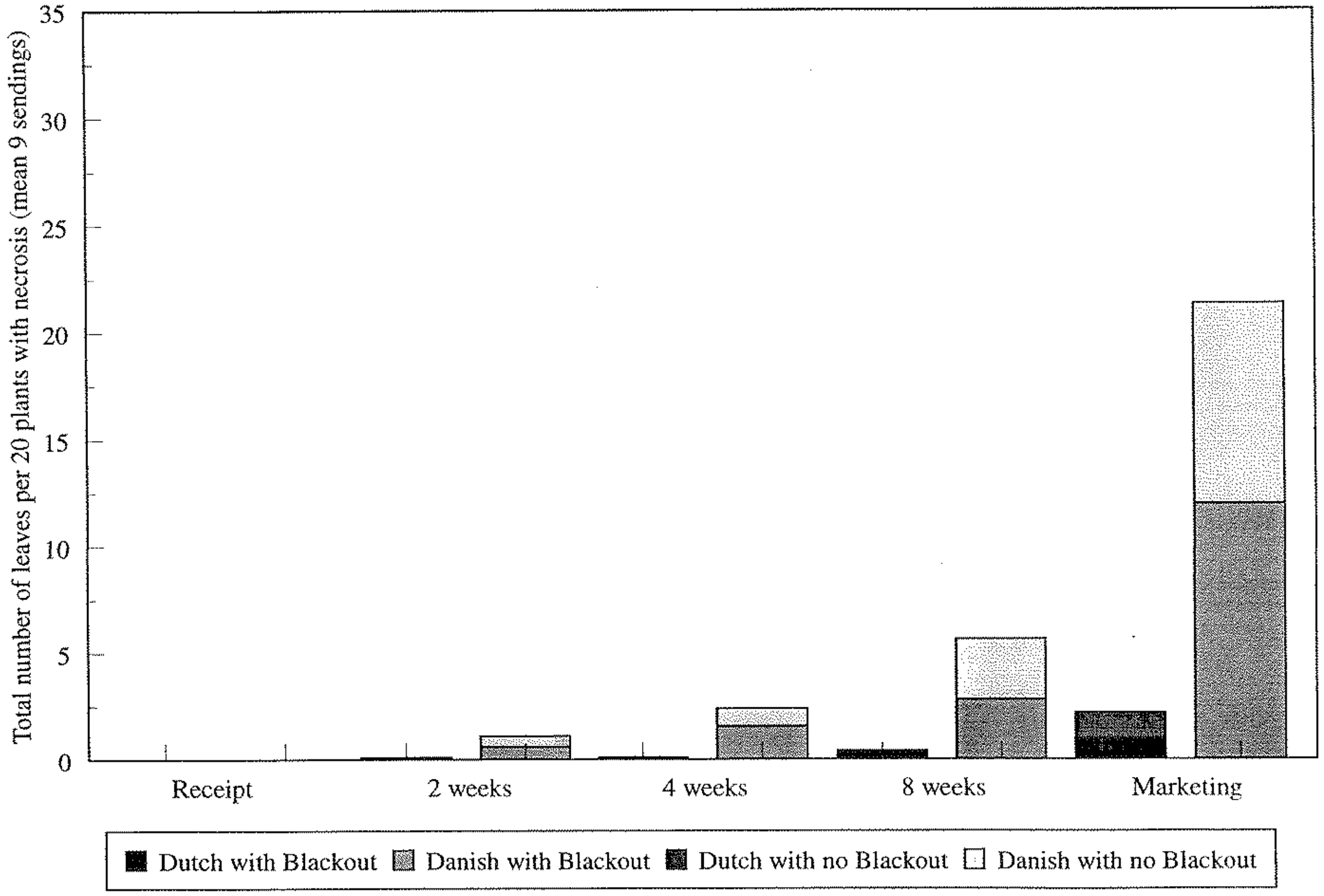
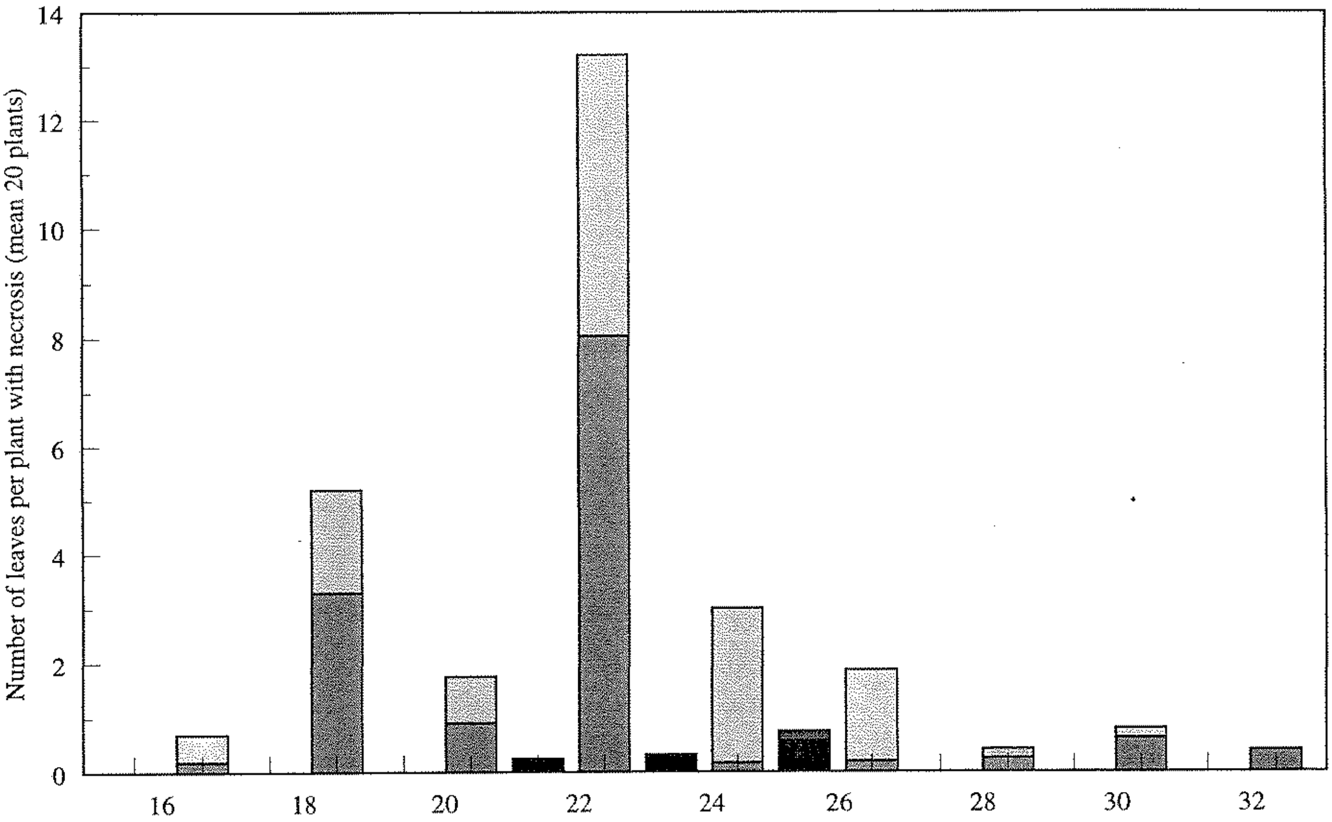


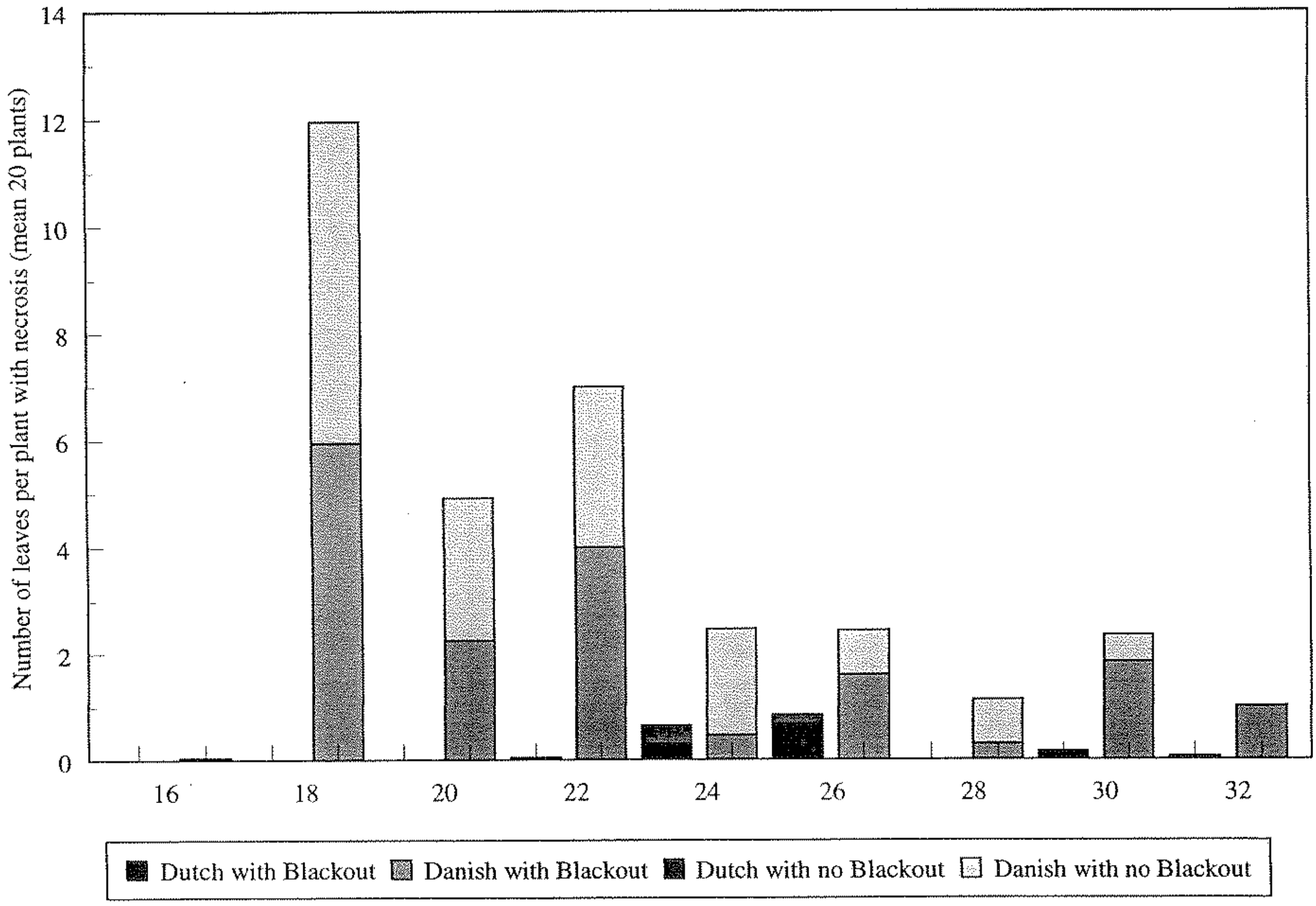
Figure 4.1

Effect of cultural regime and source of material on the level of leaf necrosis at marketing - from week 16 until week 32

Standard Regime - Cultivar 'Jytte'



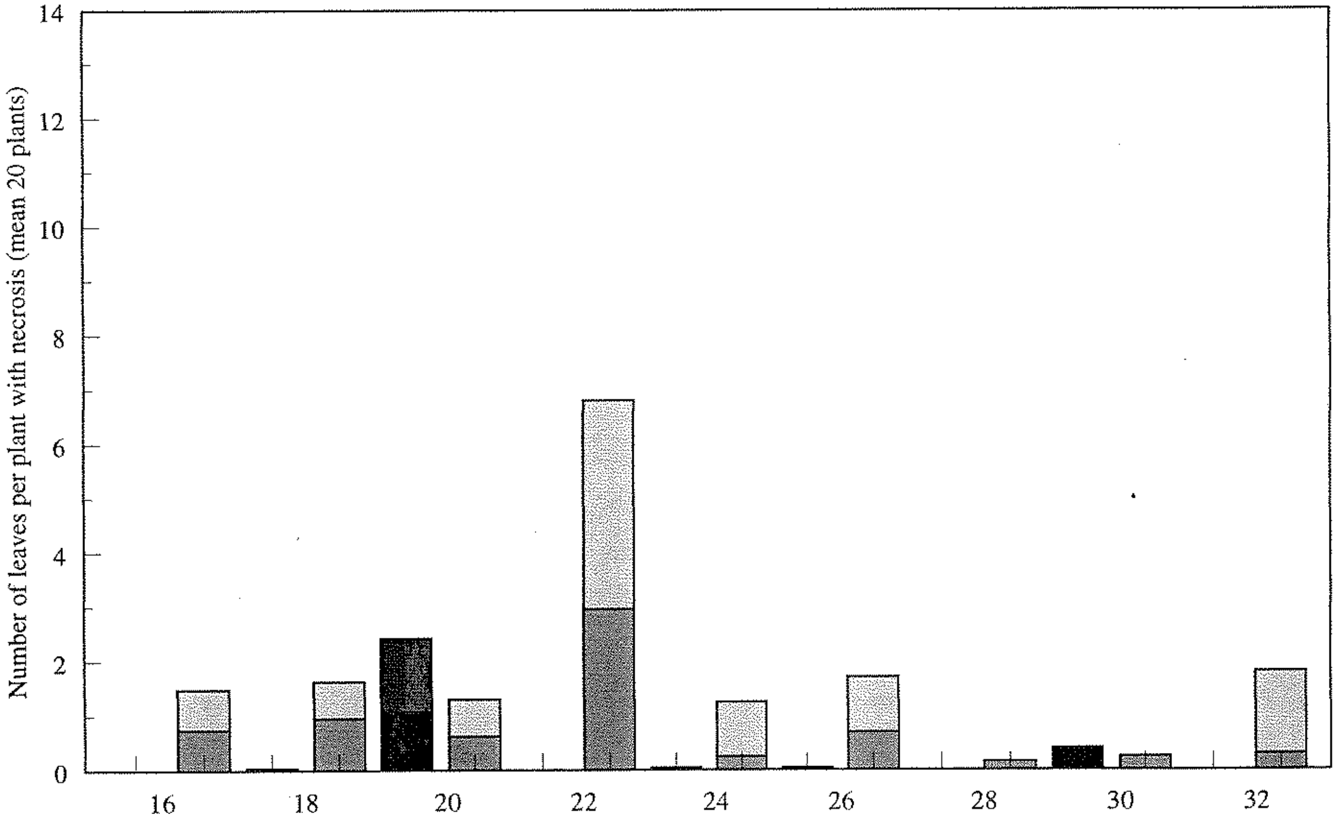
Stressed Regime - Cultivar 'Jytte'



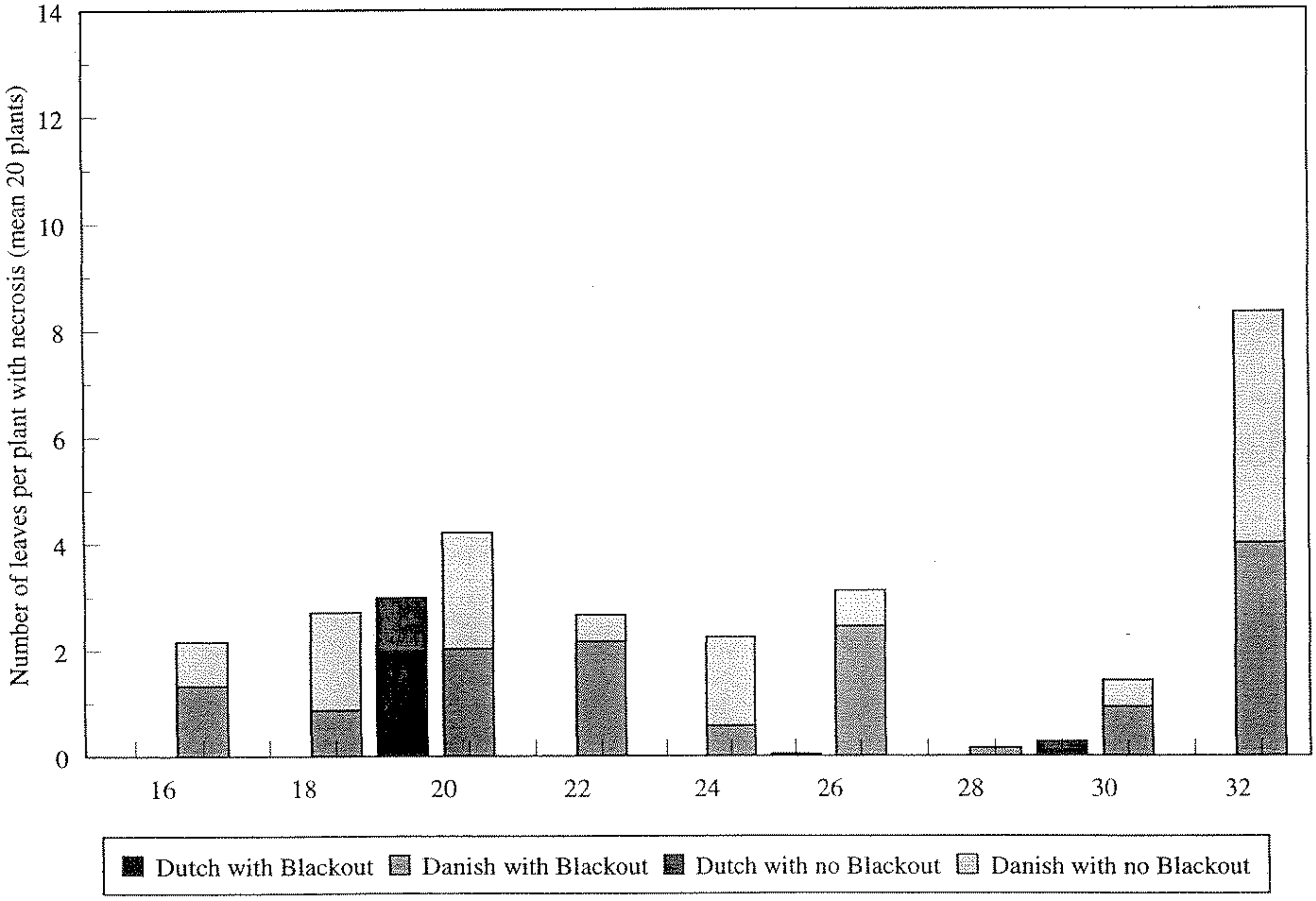
APPENDIX V

Figure 4.2 Effect of cultural regime and source of material on the level of leaf necrosis at marketing - from week 16 until week 32

Standard Regime - Cultivar 'Netja'



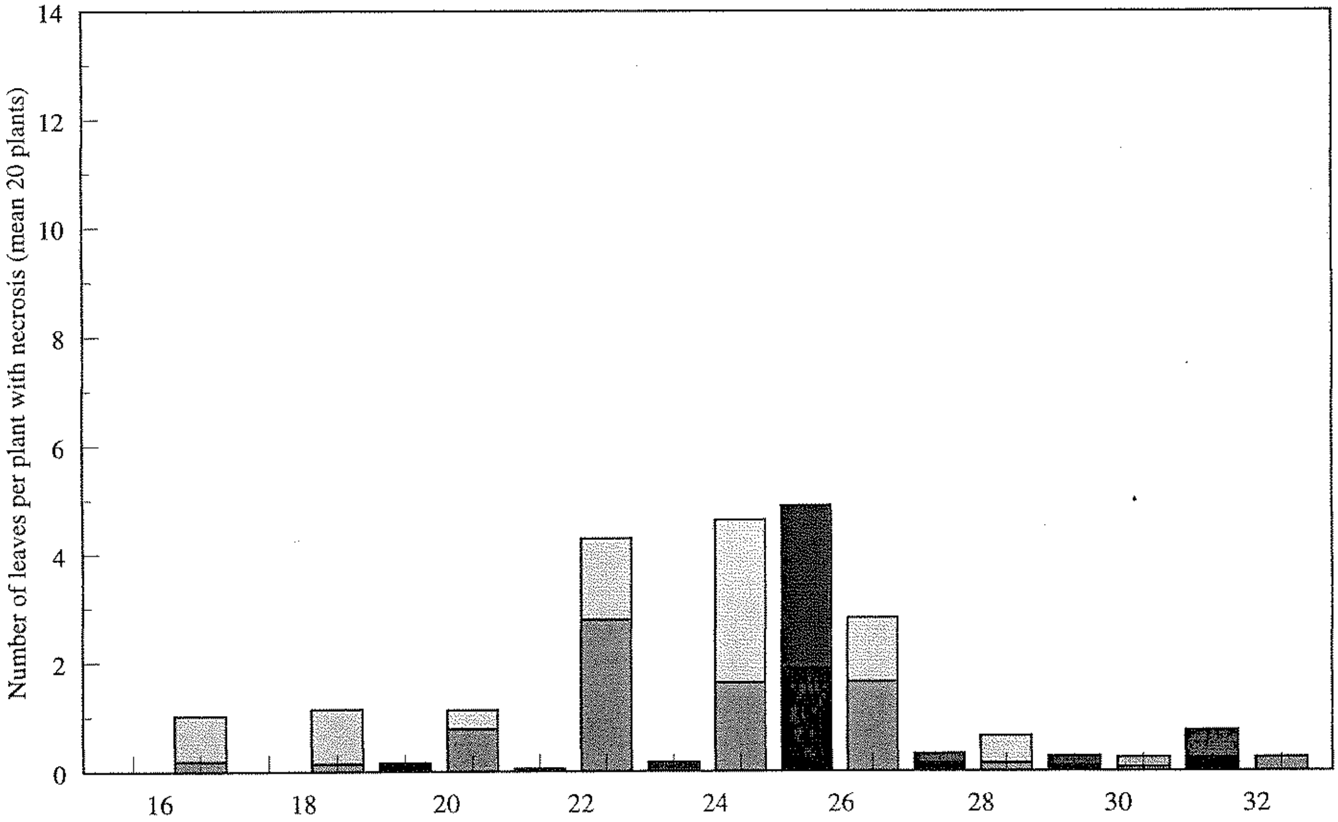
Stressed Regime - Cultivar 'Netja'



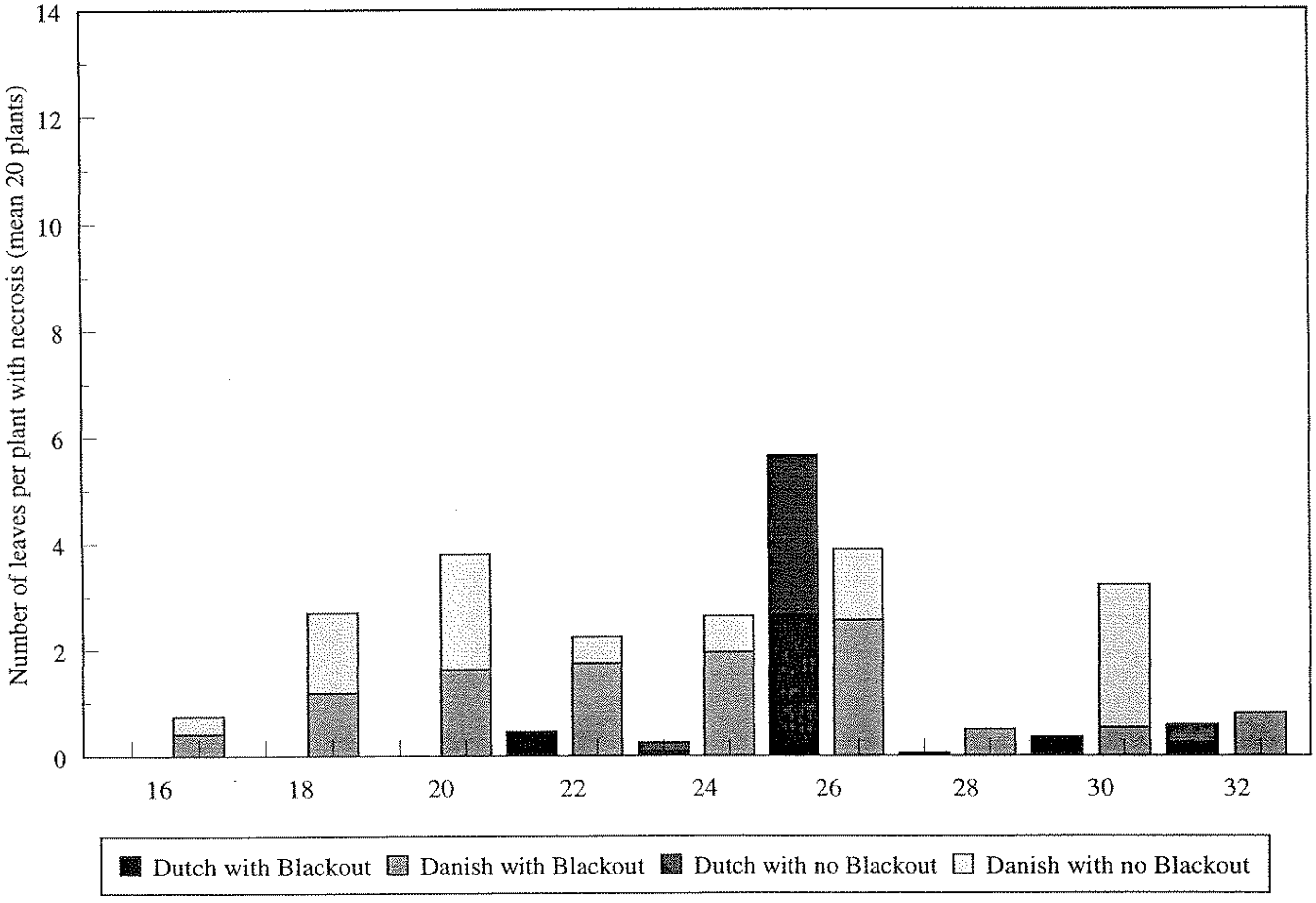
APPENDIX V

Figure 4.3

Effect of cultural regime and source of material on the level of leaf necrosis at marketing - from week 16 until week 32



Standard Regime - Cultivar 'Britt'



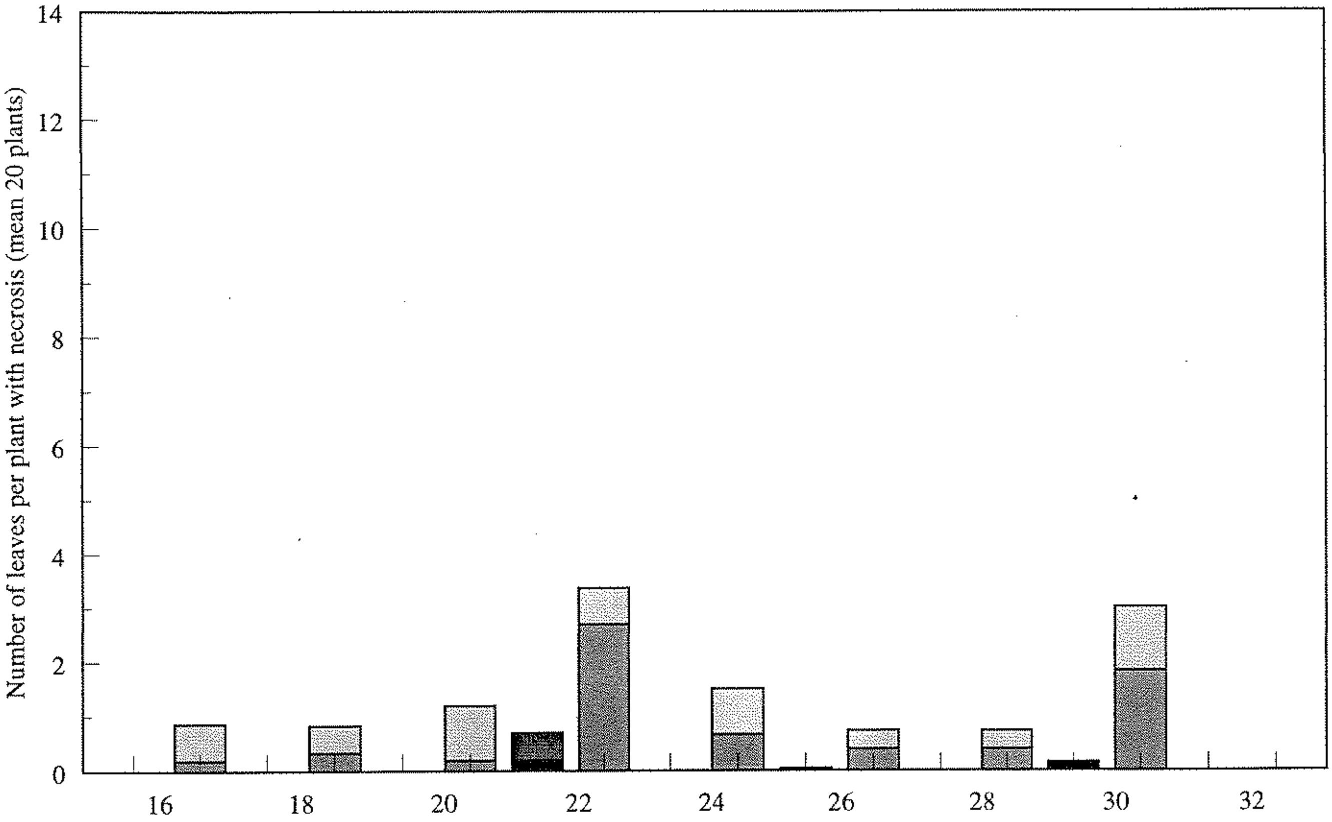
Stressed Regime - Cultivar 'Britt'

APPENDIX V

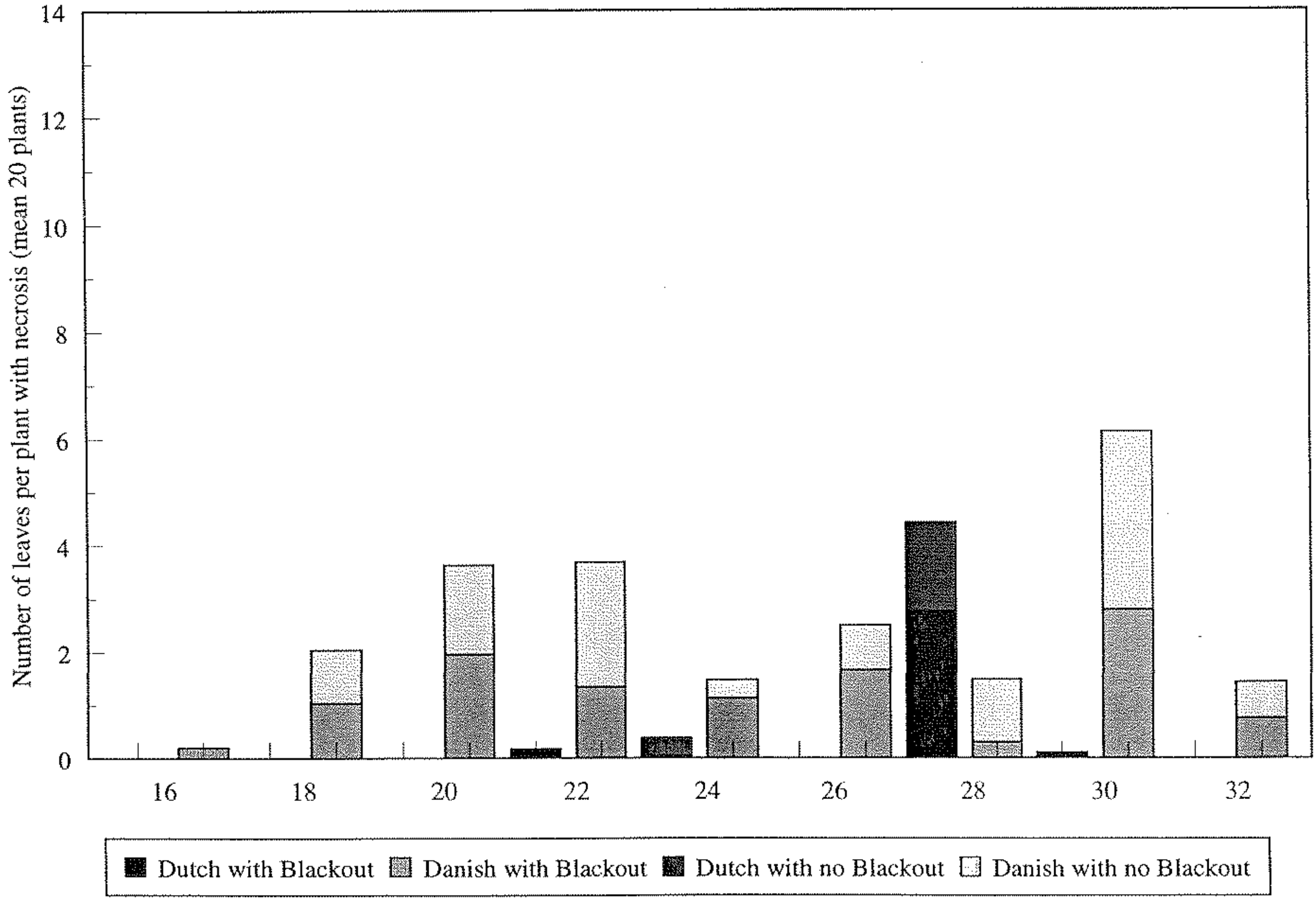
Figure 4.4

Effect of cultural regime and source of material on the level of leaf necrosis at marketing - from week 16 until week 32

Standard Regime - Cultivar 'Camilla'



Stressed Regime - Cultivar 'Camilla'

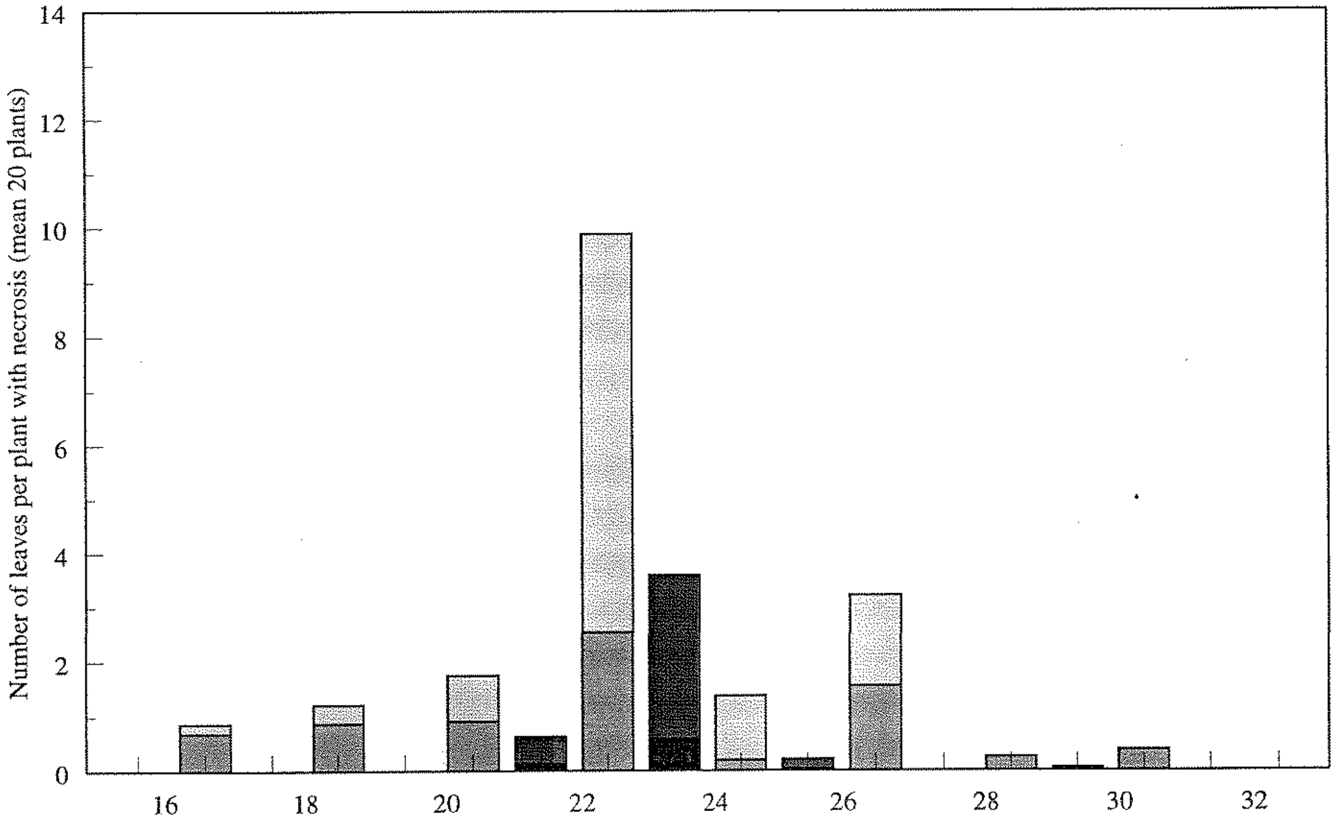


APPENDIX V

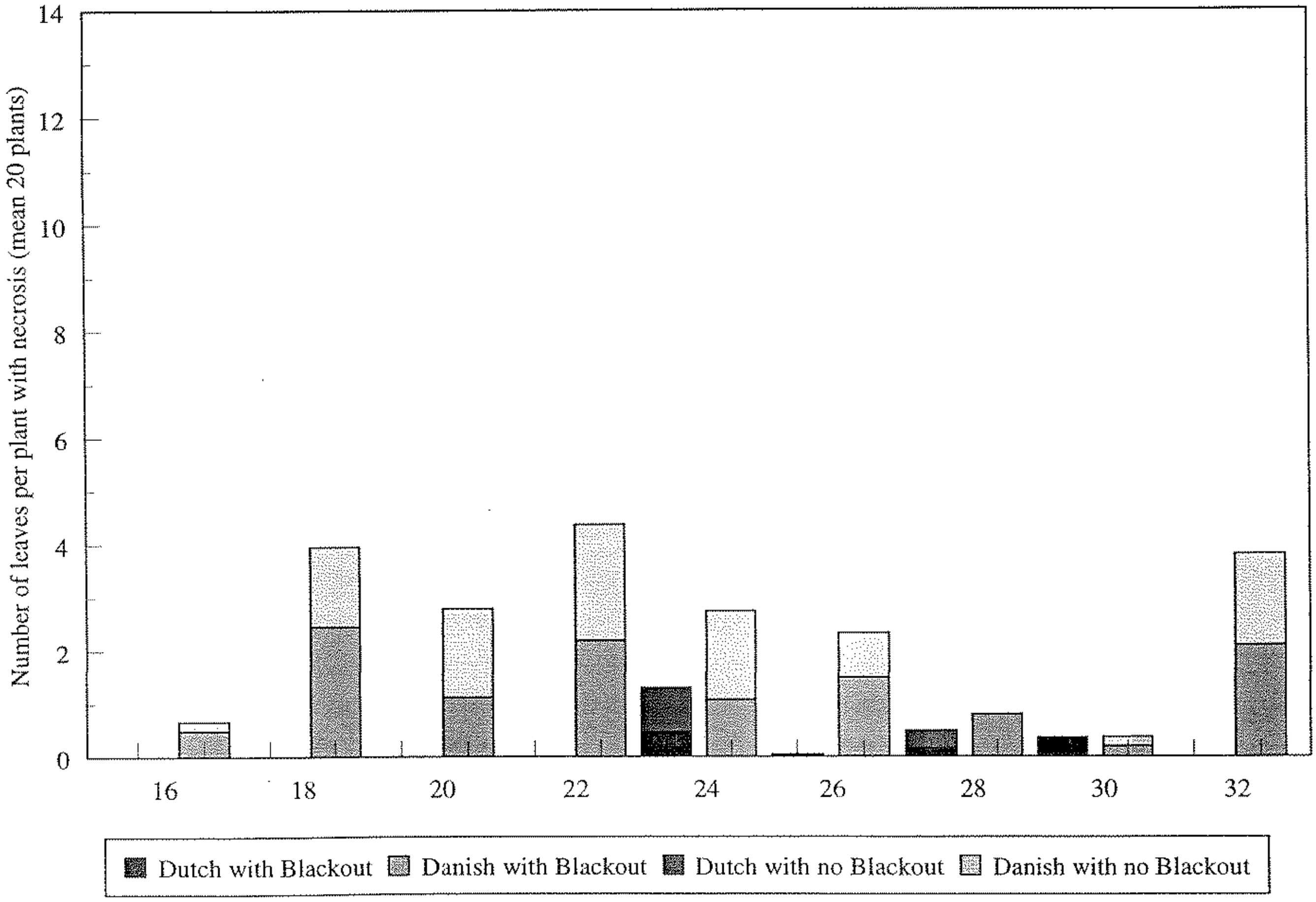
Figure 4.5

Effect of cultural regime and source of material on the level of leaf necrosis at marketing - from week 16 until week 32

Standard Regime - Cultivar 'Annebell'



Stressed Regime - Cultivar 'Annebell'



APPENDIX VI

Grower Survey

HRI EFFORD

QUESTIONNAIRE

RIEGER BEGONIA : LEAF NECROSIS ASSESSMENT 1994

CODE:

This questionnaire is designed to assess incidence of "leaf necrosis" in 1994 and previous year, and cultural factors which growers use and may have changed recently. Please tick or delete relevant answers. All information given will be treated in strict confidence and will not be duplicated or published. Please answer as many questions as possible.

		1994	**1993**
1. Level of necrosis present	None	____	____
	Slight	____	____
	Moderate	____	____
	Severe	____	____

		Wk No.	**1994**	**1993**
2. Time of year symptoms apparent	Jan-Mar	1-13	____	____
	Apr-May	14-21	____	____
	Jun-Aug	22-34	____	____
	Sep-Oct	35-43	____	____
	Nov-Dec	44-52	____	____

3. Whereabouts on the plants are symptoms found and severity None = 0 Severe = 5	Young cutting leaves	____
	New growth	____
	Whole plant	____

4. At what point does appear in the crop

cutting material received	____
within 1-2 weeks	____
3-5 weeks	____
5 weeks +	____

5. What varieties do you find affected:

Jytte ___
Camilla ___
Anita ___
Bella ___
Jutta ___
Ricky ___

Netja ___
Annebell ___
Britt ___
Annika ___
Nelly ___
Ilona ___

Blenda ___
Kleo ___
Louise ___
Asani ___
Christel ___
D. Netja ___

Others (please state)
____
____

6. Source of cutting material :

Danish ___
Dutch ___
Own ___
Other ___

Propagator/Supplier ____

7. Type of cutting :

Leaf ___
Top ___

8. Size of cutting (mostly grown)

Jiffy 7 ___
5 cm Net Pot ___
6.5 cm Net Pot ___
Unrooted ___
Other, please state____________

CULTURAL DETAILS:

If possible please supply compost/leaf analysis of affected plant/s.

Compost type ______________________________ and ____________pH.

NUTRITION - Do you apply the following in liquid feeding, please tick as appropriate

Ammonium Nitrate ____
Calcium Nitrate Is this fed from a separate tank YES/NO ____
Potassium Nitrate ____
Magnesium Nitrate ____
Mono ammonium phosphate ____
Single super phosphate ____
Nitric Acid ____
Phosphoric acid ____
Iron sequestion ____
Proprietary feed ____ what type? ____
Other, please state

Do you feed every watering YES/NO at what level__________mS

Ratio: N: P: K/ppm:__________________pH__________________
Water source: (e.g. Mains, borehole, rain) ____________________
Include water analysis details if possible, please tick if you do ____

Watering by:

- hand overhead ____
- ebb and flow ____
- ebb and flood ____
- capillary - below ____
- dripper per pot ____

Shade level (if screen present) ____________ W/m^2

Do you fleece your plants YES/NO

and for what period in cropping:

First 2 wks ___
3 wks ___
4 wks ___
After spacing ___

SPACING:

Summer	**Winter**
Plants kept at pot thick for ___ wks	Plants kept at pot thick for ___ wks
Mid spacing YES/NO-at ___/m^2___ wks	Mid spacing YES/NO-at ___/m^2___ wks
Final spacing at .../m^2 at ___ wks	Final spacing at .../m^2 at ___ wks

BLACKOUT

Do you use blackout	YES/NO
Type of material e.g. polythene, woven,	___________
How long do you Blackout per day	___________ hrs
length of period from	wk___ to wk ___
Do you use whitewash on your glass	YES/NO If YES from wk ___ to wk ___

LIGHTING

Do you use supplementary lighting (SON/T) YES/NO

If YES for what length per day _____ hrs and period from wk ___ to wk ___

Do you use Incandescent lighting YES/NO

if YES for what length per day ________ hrs and period from wk ___ to wk ___

Growing temperature: _____ °C day _____ °C night vent _____ °C

Growing humidity 40-50% 50-65% 65-75% 75% + RH

Do you apply DIF or DROP YES/NO - °C drop ___ for ___ hrs

CHEMICAL APPLICATIONS

Do you use sulphur burners YES/NO

Source of Cycocel ____________ Cycocel rate applied _____ ml/l

Source of spreader ____________ Spreader rate applied _____ ml/l

Any other details/comments you wish to provide:

Thank you for your help.

Please return in prepaid addressed envelope provided

Andrew K Fuller
Horticulture Research International
Efford
LYMINGTON
Hants
SO41 0LZ

Tel: 01590 673341
Fax: 01590 671553

APPENDIX VII

Table 2 Growing Media Analysis at potting

		Vapo B3 Potting Media (averaged across nine pottings)
Ammonia-N	mg/l	36.0
Nitrate-N	mg/l	11.4
Total-N	mg/l	47.4
Phosphorus-P	mg/l	30.8
Potassium	mg/l	222.0
Magnesium	mg/l	30.0
Calcium	mg/l	55.6
Sodium	mg/l	18.0
Sulphate	mg/l	447.4
Boron	mg/l	0.24
Copper	mg/l	0.12
Manganese	mg/l	0.24
Zinc	mg/l	0.12
Iron	mg/l	2.30
Chloride	mg/l	33.0
Conductivity	uS/cm	252.0
pH Value		6.2
Density	kg/m^3	311.0
Dry Matter %		26.9
Dry Density		83.7

APPENDIX VIII

Table 3 Propagation Media and Leaf Tissue Analysis

		Dutch and Danish cutting material		
		Dutch	Danish	%
Propagation Media				
Ammonia-N	mg/l	6.0	51.0	+ 45
Nitrate-N	mg/l	140.4	87.0	- 53
Total-N	mg/l	146.4	138.0	+ 8
Phosphorus-P	mg/l	20.4	18.0	- 2
Potassium	mg/l	84.0	102.0	+ 18
Magnesium	mg/l	42.0	21.0	- 21
Calcium	mg/l	175.8	160.8	- 15
Sodium	mg/l	33.0	33.6	0
Sulphate	mg/l	98.4	305.4	+ 207
Boron	mg/l	<0.06	0.06	-
Copper	mg/l	0.06	<0.06	-
Manganese	mg/l	0.06	0.18	-
Zinc	mg/l	0.48	<0.06	-
Iron	mg/l	1.02	0.24	-
Chloride	mg/l	43.2	46.8	+ 3
Conductivity	uS/cm	273.0	265.0	- 8
pH Value		6.03	5.45	-
Density	kg/m^3	391.0	323.0	-
Dry Matter %		17.9	19.7	-
Dry Density		70.0	63.6	-
Leaf Tissue				
Nitrogen	% DM	3.78	3.77	-
Phosphate-P	% DM	0.48	0.52	-
Potassium	% DM	1.82	3.40	-
Magnesium	% DM	0.45	0.37	-
Calcium	% DM	1.17	1.80	-
Copper	mg/kg DM	6.4	8.4	-
Manganese	mg/kg DM	66.0	30.0	-
Iron	mg/kg DM	252.6	195.6	-

APPENDIX IX

Table 4 Growing Media and Leaf Tissue Analysis

		Observation week 12 cv Kleo	
Growing Media		**Healthy Plants**	**Leaf Necrosis**
Ammonia-N	mg/l	2.4	2.4
Nitrate-N	mg/l	54.0	21.6
Total-N	mg/l	56.4	24.0
Phosphorus-P	mg/l	9.6	10.8
Potassium	mg/l	156.0	114.0
Magnesium	mg/l	16.8	11.4
Calcium	mg/l	45.6	28.8
Sodium	mg/l	26.4	36.6
Sulphate	mg/l	63.6	127.2
Boron	mg/l	0.06	0.06
Copper	mg/l	<0.06	<0.06
Manganese	mg/l	<0.06	<0.06
Zinc	mg/l	0.06	0.18
Iron	mg/l	0.54	0.06
Chloride	mg/l	50.4	45.0
Conductivity	uS/cm	179.0	139.0
pH Value		6.96	6.86
Density	kg/m^3	565.0	561.0
Dry Matter %		14.8	15.6
Dry Density		83.6	87.5
Leaf Tissue			
Nitrogen	% DM	3.48	2.45
Phosphate-P	% DM	0.63	0.62
Potassium	% DM	2.72	2.05
Magnesium	% DM	0.71	0.83
Calcium	% DM	1.31	2.53
Copper	mg/kg DM	6.4	4.0
Manganese	mg/kg DM	66.0	175.0
Iron	mg/kg DM	252.6	356.0

APPENDIX X

Table 5.1 Growing Media Analysis at Marketing

		Comparing between *standard* and *stressed* growing environments for Danish plant material							
Analysis		**Britt**		**Camilla**		**Jytte**		**Netja**	
Ammonia-N	mg/l	4.1	*2.4*	n/a	*1.8*	3.6	*n/a*	9.0	*1.8*
Nitrate-N	mg/l	279.0	*274.2*	n/a	*201.0*	134.4	*n/a*	171.6	*147.6*
Total-N	mg/l	283.2	*276.6*	n/a	*202.8*	138.0	*n/a*	180.6	*149.4*
Phosphorus-P	mg/l	12.6	*18.0*	n/a	*12.0*	4.8	*n/a*	10.2	*9.0*
Potassium	mg/l	210.0	*186.0*	n/a	*126.0*	138.0	*n/a*	144.0	*120.0*
Magnesium	mg/l	62.4	*72.6*	n/a	*51.0*	16.2	*n/a*	49.2	*26.4*
Calcium	mg/l	208.8	*227.4*	n/a	*146.4*	98.4	*n/a*	0.6	*93.0*
Sodium	mg/l	49.2	*34.2*	n/a	*33.6*	35.4	*n/a*	46.8	*27.0*
Sulphate	mg/l	151.2	*255.0*	n/a	*150.6*	30.6	*n/a*	124.2	*51.6*
Boron	mg/1	0.181	*0.18*	n/a	*0.12*	0.06	*n/a*	0.12	*0.12*
Copper	mg/l	0.12	*0.06*	n/a	*0.06*	<0.06	*n/a*	0.12	*0.06*
Manganese	mg/l	0.06	*0.12*	n/a	*0.12*	<0.06	*n/a*	0.06	*0.06*
Zinc	mg/l	0.18	*0.12*	n/a	*0.12*	0.06	*n/a*	0.30	*0.12*
Iron	mg/l	1.08	*0.60*	n/a	*0.48*	0.24	*n/a*	1.08	*0.48*
Chloride	mg/l	84.0	*41.4*	n/a	*34.8*	48.6	*n/a*	53.4	*20.4*
Conductivity	uS/cm	480.0	*473.0*	n/a	*346.0*	249.0	*n/a*	333.0	*245.0*
pH Value		5.87	*5.33*	n/a	*5.48*	6.35	*n/a*	6.08	*5.56*
Density	kg/m^3	525.0	*477.0*	n/a	*544.0*	548.0	*n/a*	552.0	*528.0*
Dry Matter %		14.7	*16.5*	n/a	*17.5*	15.3	*n/a*	14.1	*17.4*
Dry Density		77.2	*78.7*	n/a	*77.2*	76.9	*n/a*	77.8	*78.2*

N.B. Figures in italics represent the stressed growing environment

APPENDIX X

Table 5.2 Leaf Tissue Analysis at Marketing

Comparing between *standard* and *stressed* treatments
with or without symptoms of leaf necrosis
Danish material potted week 16 - analysis week 26

Analysis/cv		**Britt Standard Healthy**	**Britt Standard Necrosis**	**Britt Stress Healthy**	**Britt Stress Necrosis**
Nitrogen	% DM	4.00	3.01	4.08	3.41
Phosphorus	% DM	0.53	0.88	0.57	0.94
Potassium	% DM	2.83	3.95	2.51	3.88
Magnesium	% DM	0.43	0.86	0.51	0.99
Calcium	% DM	1.26	2.30	1.41	2.58
Manganese	mg/kg DM	89.0	276.0	151.0	322.0
Copper	mg/kg DM	11.3	5.1	12.1	5.6
Iron	mg/kg DM	499.5	660.0	664.3	739.5

Table 5.3

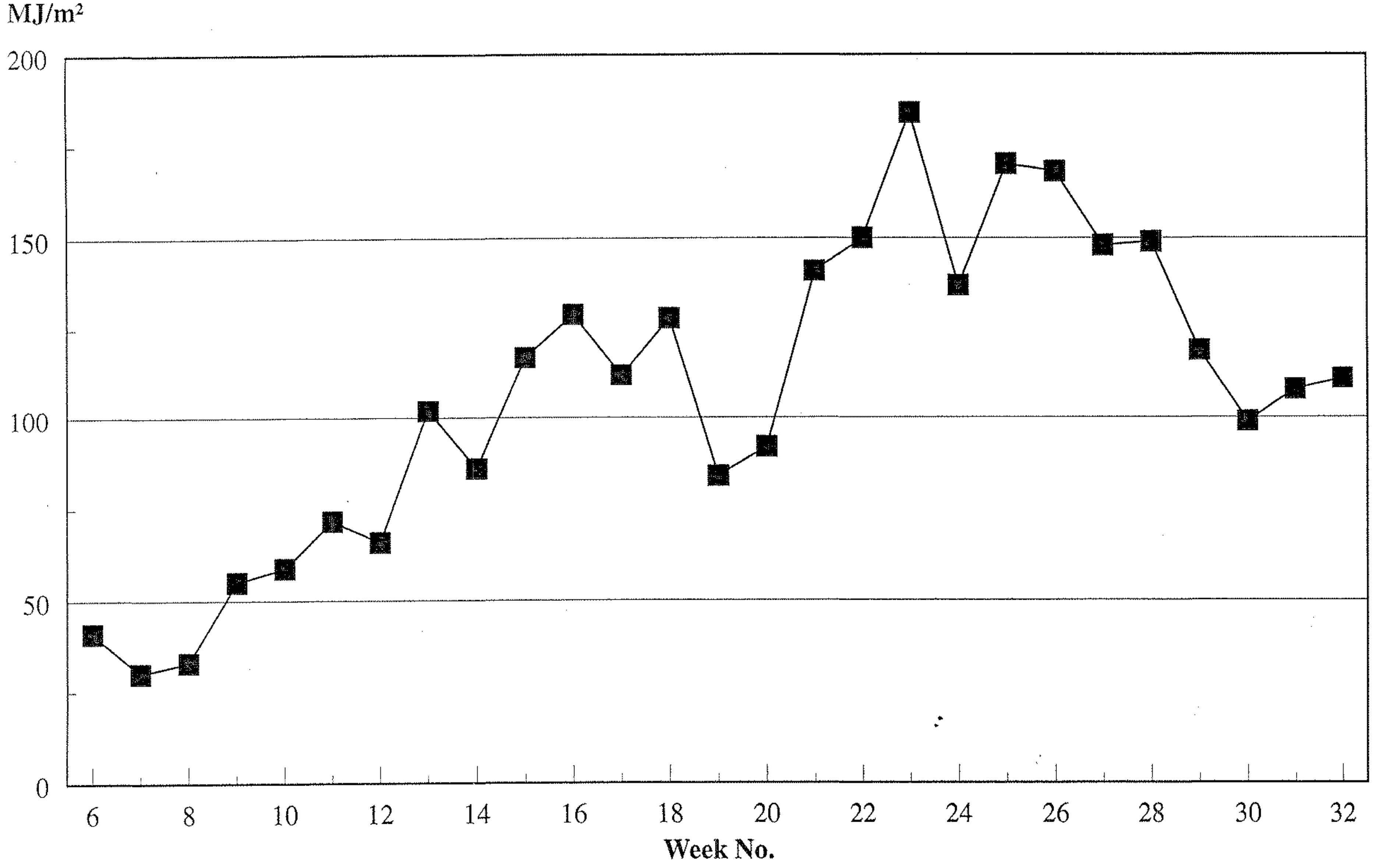
Comparing between *standard* and *stressed* treatments
with or without symptoms of leaf necrosis
Danish material potted week 16 - analysis week 26

Analysis/cv		**Netja Standard Healthy**	**Netja Standard Necrosis**	**Netja Stress Healthy**	**Netja Stress Necrosis**
Nitrogen	% DM	3.92	3.17	3.54	3.06
Phosphorus	% DM	0.59	0.78	0.65	0.81
Potassium	% DM	2.43	3.63	2.49	2.99
Magnesium	% DM	0.41	0.69	0.49	0.74
Calcium	% DM	1.10	1.88	1.39	1.96
Manganese	mg/kg DM	58.0	192.0	99.0	217.0
Copper	mg/kg DM	9.6	6.3	10.9	5.4
Iron	mg/kg DM	338.5	610.0	348.0	564.0

Appendix XI

Figure 5

Weekly solar radiation totals for HRI Efford
1994



APPENDIX XII

PHOTOGRAPHIC PLATES

APPENDIX XII

Rieger Begonia: Leaf Necrosis

Plate 1

First visible symptoms of leaf necrosis

Plate 2

Development of symptoms on 'mother leaves'

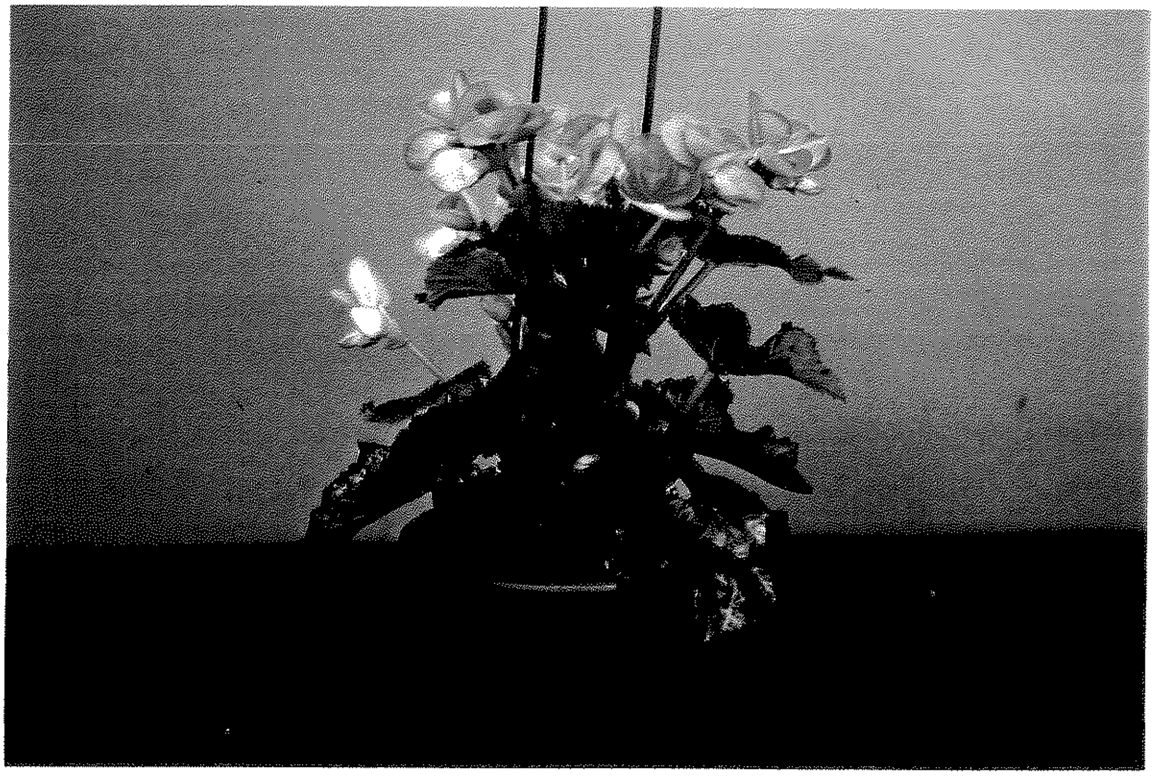
APPENDIX XII

Rieger Begonia: Leaf Necrosis

Plate 3

Severe symptoms developing

Plate 4



Unmarketable plant due to leaf necrosis

APPENDIX XII

Treatments

Standard blacked out	Standard no blackout	Stressed blacked out	Stressed no blackout

Plate 5

Dutch Planting Week 16

Plate 6

Danish Planting Week 16

Treatments

Standard blacked out	Standard no blackout	Stressed blacked out	Stressed no blackout

Copy of contract, terms and conditions

Contract between HRI (hereinafter called the "Contractor") and the Horticultural Development Council (hereinafter called the "Council") for research/development project.

1. TITLE OF PROJECT

Contract No: PC46a
Contract date: 14.3.94

REIGER BEGONIAS: INVESTIGATION IN TO CULTURAL FACTORS THAT CAUSE LEAF NECROSIS TO ENABLE REGIMES TO BE DEVELOPED WHICH CAN ERADICATE THIS PLANT QUALITY PROBLEM

2. BACKGROUND AND COMMERCIAL OBJECTIVE

Stress related defects such as leaf scorch and leaf blister on Reiger Begonias have previously been associated with high light conditions during the summer period. Although this is primarily the case, leaf necrosis can occur at other times of the production period and the causes of this problem need investigating further so that potential remedies can be produced. The extent of the problem varies between batches of plants but losses of up to 20% of a batch at any particular time of year can occur. Previous work at HRI Efford have concentrated on the summer period using shade screens at different light levels and using humidification to see if this can reduce incidence of leaf scorch by evaporative cooling of the leaf tissue (PC46). Unfortunately, the outside solar radiation levels during the periods of the trial were not as high as would have been expected during the summer months and very little leaf scorch occurred in the unshaded/unhumidified control compartments to test the effects of humidity as a control measure. It was also noticed by growers during these seasons that they did suffer from leaf scorch on certain batches but a common factor has not been apparent.

Therefore, this project aims to determine the factors that induce leaf necrosis so that potential remedies can be sought. In order to evaluate the cause the trial would run throughout the season with a standard environment and a "stress" environment which will be targeted to try and induce the symptoms. Fortnightly plantings will be used to simulating commercial practice. Regular contact with leading Begonia growers via the HDC co-ordinator (at fortnightly intervals) will also ensure the maximum amount of data is gleaned from the industry with respect to the incidence of this disorder. In view of the fact the problem occurs during the first few weeks of production the crops will only be evaluated during the first six weeks and then removed to allow greater throughput of batches of plant material.

The aim of this project would be to concentrate on a larger proportion of the production period as it is more likely that leaf necrosis can be induced this way rather than targeting one single period of the year as in the 1992/1993 trials (PC46). Varietal response to the cultural treatments would also need to be examined, hence a range of cultivars selected as being particularly prone to leaf necrosis would be used.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

A greater understanding of the cultural requirements for successful production of Reiger Begonias with full economic assessments comparing treatments and schedules. Improved quality and shelf-life of the final product at point of sale and in the home environment.

Further benefits may be evident as a reduction in both wastage and the additional labour usage required for quality control where the problem is prevalent.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

To identify the factors which can induce leaf necrosis on a range of Reiger Begonia cultivars in order to determine potential cultural treatments which can be used to alleviate the onset of such damage throughout the production period.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

HRI Efford: PC46 Summer shading/humidification work on Reiger Begonias looked at the influence of humidification combined with the use of shade screens for manipulation of temperature and incident of light and effect on plant quality.

MAFF funded project K102-9D. To develop energy efficient systems for crop production.

6. DESCRIPTION OF THE WORK

Cultivars - Camilla
Jytte
Annebell
Britt
Netja

These cultivars have been selected with reference to grower's experience to include types which have proven to be particularly prone to leaf damage/necrosis.

Treatments -

Cuttings will be delivered fortnightly from Dutch and Danish sources potted up in 13cm pots and then grown on as under normal commercial practice or in the stress regime detailed as follows:

Stress (Standard) regime:

1. No woven fleece (woven fleece removed 2 weeks after plant arrival)
2. Maintain lower humidities after first week (keep humid under fleece for 2 weeks)
3. Two weeks long days; 2 weeks short days (No short days)
4. Final spacing after three weeks in the winter (half space after three weeks then final space after five weeks)
5. Final spacing after three weeks in the summer (final spacing after four weeks and cover with fleece for five days)

Design:

Replicated trial with the main plots of temperature and lighting in 2 benched compartments in K-block.

Blocks of each variety within the compartments will be in the same geographic location. Each varietal block will consist of 2 x 20 plants/compartment.

Culture: To be grown in 13 cm pots.
Standard PGR regime for growth control to be followed.
Routine IPM programme for pest and disease control.

Records:

1. Crop diary
2. Leaf damage/necrosis assessment on a weekly basis for 6 weeks.
3. P & D assessments plus physiological damage to foliage/flower development
4. Photographs at all stages as appropriate
5. Grower questionnaires re. incidence of leaf necrosis during season

7. COMMENCEMENT DATE AND DURATION

Start date 01.02.94; duration 11 months.

The final report will be produced by the end of December.

8. STAFF RESPONSIBILITIES

Dr David Hand	HRI Efford
HDC Co-ordinator:	Peter Hill, Hill Brothers Chichester

Contract No: PC/46a

TERMS AND CONDITIONS

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

Signed for the Contractor(s)

Signature...
Position... Commercial & Marketing Manager HPI
Date.................4/8/94..................

Signed for the Contractor(s)

Signature...
Position...
Date...

Signed for the Council

Signature...
Position.......CHIEF EXECUTIVE.......
Date..................18.3.94...............