HORTICULTURE RESEARCH INTERNATIONAL
EFFORD

REPORT TO :

Horticultural Development Council
8 Lavant Street
Petersfield
Hampshire
GU32 3EW

Tel: 0703 63736
Fax: 0703 65394

Mr John Weir
Electricity Association Technology Ltd
NAC
Stoneleigh
Kenilworth, Warwickshire
CV8 2LS

Tel: 0203 696512
Fax: 0203 696360

HRI CONTRACT MANAGER : Miss M A Scott
HRI Efford
Lymington
Hampshire
SO41 OLZ

Tel: 0590 673341
Fax: 0590 671553

Period of Investigation: August 1991 - February 1992
Date of Issue of Report: July 1992
No. of Pages in Report: 32
No. of Copies of Report: 7
This is HRI Copy No. 1: Issued to HDC

CONTRACT REPORT

Poinsettia: **Potential for the production of miniature bracted plants for the Christmas market**
HDC PC43

PRINCIPAL WORKERS

HRI EFFORD

Mrs E J Hemming BSc Hons (Hort), M.I.Hort (Author of Report)	Technical Officer
Mrs S Foster	Scientific Officer
Mr R Goode	Assistant Scientific Officer
Miss C Jenkins	Assistant Scientific Officer
Mr C A J Hemming	Nursery Staff
Mr S Langford	Nursery Staff
Miss A Peek	Nursery Staff
Mrs M Jenvey	Nursery Staff

HRI LITTLEHAMPTON

Miss S Hammond	Statistician

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

Margaret A Scott
Deputy Head of Station
Date ..... 28/8/92 .....

Report authorised by .....
Signature

M R Shipway
Head of Station
HRI Efford
Lymington
Hants
SO41 OLZ

Date ..... 28/8/92 .....

CONTENTS

SUMMARY

Poinsettia (*Euphorbia pulcherrima*) sales form a major part of the traditional Christmas market for pot plants. The majority of production is of red bracted cultivars in 11 to 13 cm pots. As with any product line, consumer interest must be maintained by the introduction of new cultivars, colours and forms.

The Horticultural Development Council (HDC), through levy funding, commissioned trials work at HRI Efford in Autumn 1991. The investigation looked at the potential for the production of miniature branched Poinsettia plants for the Christmas market using supplementary lighting to extend the product range available.

Additional funding by the Electricity Association Technology Ltd (EA) was provided to enable an economic appraisal of the lighting treatments to be carried out.

The cultivar used was Eckespoint Lilo brought in from a commercial young plant supplier as potted rooted cuttings in weeks 35, 37 and 38 (August - September 1991) in both 6 cm and 8 cm pots. The following supplementary lighting treatments were applied.

1. Lighting with high pressure sodium (SON/T) lamps at 2500 lux for 16 hours per day during the long day period and 10 hours during short days.

2. As (1) but light level of 4000 lux.

Assessments were made at the marketable stage, with plants subsequently transferred to controlled facilities for monitoring 'post marketing'.

All three dates of receipt produced marketable plants for the Christmas period. The pattern of results were similar for both pot sizes though the 8 cm was a larger plant overall than 6 cm. Measured parameters at marketing demonstrated little differences in plant height between lighting treatments. Plant diameter was smaller the later the receipt of cuttings. Average bract number also decreased with later sending but had a larger average bract diameter than those received earlier.

Lighting at 4000 lux gave marginally higher bract numbers which were greater in diameter than those lit at 2500 lux. Higher light intensity however did give some chlorosis of leaves, especially in 6 cm pots, which were under greater stress, relative to water management.

Shelf life assessments of leaf yellowing and cyathia drop showed a faster decline in quality from the 6 cm pots than those in 8 cm, though all plants were still 'attractive' as houseplants after five weeks.

The economics of lighting would suggest that the best financial return is achievable from lighting the crop at the lower of the two light levels at 2500 lux. The potential profit margin improved with the greater density of spacing possible with a 6 and 8 cm crop (60 and 40 plants/m^2) respectively compared to the standard 13 cm crop and the shorter the duration of lighting, ie. perfectly saleable finished products from week 37 and week 38 receipt of potted rooted cutting.

Supplementary lighting enabled crops to be produced satisfactorily from week 38 receipt, with lighting at 2500 lux proving adequate. Crop management and shelf life improved with the larger pot size (8 cm). However, returns would be greater for the 6 cm pot at closer spacing (60 plants/m^2), and provided adequate water management/nutrition was maintained, good quality plants were produced. This smaller size would also be ideal for "make up" work.

In conclusion, from the results obtained from this single trial, it would appear that successful scheduling of mini Poinsettia crops is both culturally and economically viable.

INTRODUCTION

Poinsettia can be grown in a wide range of sizes and forms. Sales of red coloured types dominate the Christmas market. To maintain the buying public's interest, new varieties, colours and forms are needed.

The production of miniature branched *Poinsettia* would add greatly to the available product range and may offer the following potential benefits to growers.

Reduction of required production period, with potential for saving energy, chemicals etc.

Spread of receipt of cuttings - week 35 to week 38.

Potential for growing at closer spacing/greater plant density therefore reducing costs per m^2, and increasing returns.

OBJECTIVE

The main objectives of the trial were:-

1) To assess the potential for the production of *Poinsettia* with 3 to 5 heads as a miniature plant for the Christmas market from week 35, 37 and 38 receipt using lighting treatment.

2) To carry out an economic appraisal of the lighting treatments used.

MATERIALS AND METHOD

Plants for the trial were supplied by Hollyacre Plants Ltd (Dummen stock) as rooted cuttings in their final containers (6 or 8 cm plastic terracotta pots). Cuttings had been rooted in pots for four weeks prior to delivery. Two applications of Cycocel (chlormequat) had also been applied during this period.

On arrival each batch of plants was transferred to its respective treatment compartment in 'K' block with computerised environmental control. Pots in carrier trays (Empot), were placed on standard benching covered with capillary matting and microperforated black polythene. The lamp type used for supplementary lighting was Poot SON/T 400W lamps.

Treatments

1. Lighting at 2500 lux for 16 hours per day in long days and 10 hours per day in short days.
2. Lighting at 4000 lux for 16 hours per day in long days and 10 hours per day in short days.

Species and Variety

Poinsettia - Eckespoint Lilo

Design

2	lighting regimes
x	
2	pot sizes
x	
3	receipt dates
12	plots in total

Plot size = single block of 100 plants (including guards). 50 plants recorded. The trial layout is given in Appendix I, page 15).

Cultural details

All plants on arrival were drenched with Benlate (benomyl) at 0.5g/litre as a preventative measure. The detailed scheduling for each batch of plants is given in the schedule on page 6.

Throughout the course of the trial, routine introductions were made of *Encarsia formosa* for whitefly (*Trialeurodes vaporariorum*), and *Amblyseius cucumeris* against thrips. Effective sciarid fly control was achieved using a compost drench of Nemasys (*Steinernema bibionis*).

Liquid feeding of plants commenced shortly after delivery. Initially this was at every watering but reduced to one watering in three as the trial progressed. The relatively small pot sizes meant that fairly frequent, light waterings were required to keep plant material in optimum condition. The feed given supplied 120 ppm N, 60 ppm $P_2 0_5$ and 120 ppm $K_2 0$. The stock feed comprised:

Material	**g/litre**
Potassium nitrate	53
Ammonium nitrate	13
Mono ammonium phosphate	20
Ammonium molybdate	0.05
Librel Fe lo	0.2

Diluted 1 in 200 Conductivity setting 1.1

All plants were pinched between 6 and 8 days after treatment commenced. Plants in 6 cm pots were pinched to three leaves whilst 8 cm pots were taken back to four leaves. A non woven fleece (Agryl) was used to cover the newly pinched cuttings for a few days afterwards to help maintain humidity levels around the shoots.

Growth regulation via chemical means was achieved using Cycocel (chlormequat 46%) at 0.075% via misting of all foliage as required, (see schedule p.6).

As plants commenced to colour change, bracts were exposed by hand to ensure even colouring.

A zero DIF (different in temperature) regime was employed throughout based on the standard growing regime for Eckepoint Lilo, with establishment at 20 to 21°C and bract initiation at 17.5 to 18.5°C for 2-3 week period. As marketing was approached, temperatures were dropped in small stages from 20°C for bract development to a finishing temperature of 15°C.

Records were taken at marketable stage when cyathia had started to open. A proportion of plants were then transferred to controlled environment facilities for subsequent shelf life testing.

Schedule for each delivery of plant material

Week No.	**35**		**37**		**38**	
Pot size (cm)	**6**	**8**	**6**	**8**	**6**	**8**
Delivery date	28 Aug		11 Sept		17 Sept	
Pinching date	4 Sept		18 Sept		24 Sept	
Long day trt. commenced	on arrival		on arrival		on arrival	
Short day trt. commenced	2 Oct		2 Oct		2 Oct	
Growth reg. application	6 Sept 14 Oct 17 Oct 23 Oct		17 Oct 23 Oct		Nil	
Colour change	23 Oct		5 Nov		9 Nov	
Marketable date	2 Dec		10 Dec		10 Dec	

Assessments

During the course of the trial, the following assessments were made:-

At maturity

1. Plant height (mm)
2. Spread (2 measurements) (mm)
3. Bract number
4. Bract diameter (mm) (diameter of coloured head)
5. Bract colour (1 = dark red 3 = pale)
6. Quality (scale 1 - 4 1 = highest quality)
7. Stem strength (1 = strong 3 = weak)

During 'shelf life'

1. Cyathia loss
2. Leaf loss

Statistical analysis

No formal statistical analysis was possible since facilities did not allow for lighting treatments to be replicated. Treatment means and variances are presented.

RESULTS

Plant height (Table 1, Figure 1, Appendix II, p.16)

Data is presented both as a table of means and graphically. As might be expected, cuttings received in week 35 gave the tallest plants in both 6 and 8 cm pot sizes. Differences in height between receipts in weeks 37 and 38 were negligible. Plant height was only marginally affected by light intensity from week 35 material, 2500 lux giving slightly taller finished plants at maturity than 4000 lux.

Comparison photographs for each treatment/pot size/week of receipt are shown in Appendix IV, plates 1-4, pages 26 and 27.

Plant spread (Table 2, Figure 2, Appendix II, p.17)

Plant spread was assessed by taking an initial measurement across the widest diameter of the plant with a second measurement taken at 90° angle to this. Mean values are shown in the appropriate table with the graph in Figure 2 page 17 showing the measurements combined to give an estimate of area (cm^2).

Earlier receipt of material gave greater diameter of spread, with week 35 in both 6 and 8 cm pots giving the largest values. As with height, the 8 cm pots were larger than 6 cm.

For the 6 cm pot size average spread was slightly larger at 4000 lux than 2500 lux for the two later receipt dates, whilst for week 35, results were the same. For 8 cm pots week 37 plants were slightly larger under 2500 lux.

Variability in spread appeared greater in 8 cm pots. Under the 2500 lux intensity, variability increased with later arrival dates. This was reduced under 4000 lux.

The framework of the plants is best demonstrated by the photographic plates (pages 26, 27 and 28). Overall, the most 'balanced' plants were considered to be from week 35 sendings.

Bract number (Table 3, Figure 3, Appendix II, p.18)

Plants grown in 8 cm pots had on average 3.11 bracts as opposed to 2.48 in the 6 cm pots. There was a distinct trend in the number of bracts counted with week of receipt, numbers increasing the earlier the arrival. While there appeared to be a small increase in the number of coloured bracts in the 8 cm pot at 4000 lux for the earlier sending, those in the 6 cm pot were similar regardless of treatment.

Bract diameter (Table 4, Figure 4, Appendix II, p.19)

For both diameter measurements, pot size appeared to have the greatest influence, with an increase of 2 cm in bract diameter in the 8 cm compared with the 6 cm.

On average, across the receipt dates, lighting at 4000 lux appeared to give slightly larger bract size especially in 6 cm pots, but effects were marginal. Greater variability in the two measurements taken was recorded under 2500 lux.

There was a trend for bract size to increase with the later plants in 6 cm pots, but this trend was reversed in the 8 cm, where bract diameter was greatest with the earlier sending. Varibility in bract size increased in the later batches.

Bract colour and stem strength

No differences were recorded between treatments.

Quality (Table 5, Figure 5, Appendix II, p.20)

Plants were scored on the integer scale from 1 to 4 with 1 being the highest quality and 4 representing an unmarketable plant. The quality and grading criteria used for both pot sizes are given below.

POINSETTIA

CRITERIA USED FOR QUALITY GRADING
CROP: MINIATURE BRANCHED PLANTS

	GRADE			
	1	**2**	**3**	**4 (un mkt)**
6 cm				
Height (mm)	100 - 125	<100 - >135	<90 - >145	<90 - >150
Bracts (minimum)	3 - 4	2 - 3	2	1
8 cm				
Height (mm)	120 - 150	<120 - >150	<110 - >160	<110 - >170
Bracts (minimum)	4 - 5	3 - 4	2 - 3	1 - 2
Shape	Symmetrical top horizontal slightly domed	May be slightly asymmetrical	Distinctly assymmetrical	-
Cyathia	Intact	Up to 10%	-	-
Bract colour	(1) Typical of variety or	(2) Slightly pale	(3) Distinctly pale	-
Leaf colour	" "	" "	" "	-
Stem strength	(1) Strong	(2) Intermediate	(3) Weak	-

The highest quality (i.e. lowest score) were from week 35 plants followed by week 37 and then week 38. The influence of lighting level showed that 2500 lux gave as good or only slightly lower equality than 4000 lux in the majority of cases.

The apparent trends were however, very small and all plants made extremely saleable items.

Overall comments

Some chorosis was encountered in plants under 4000 lux especially in the 6 cm pot size, Appendix IV, plate 5, page 28 especially where plants became water stressed. Adequate irrigation/feeding of this very small pot size proved quite difficult. It was found beneficial to provide several, brief waterings rather than a single, prolonged one.

Shelf life

Visual assessments of cyathia and leaf yellowing/loss demonstrated the very good keeping qualities of the plants so long as adequate watering was provided. Plant in 6 cm pots tended to yellow more rapidly than those in 8 cm and lost leaves more noticeably. A majority of plants subjected to shelf life assessments were still acceptable as house plants in late February when recording was terminated.

With regard to lighting treatment during production, bract colour and general vitality of plant material after an extended period of shelf life was better from plants lit during the course of the trial at 2500 lux.

Economics of lighting

The detailed calculations and criteria used for the economic appraisal of the lighting treatments are given in Appendix III, page 21.

The summary below presents the average returns per m^2 taking into account the cost of lighting treatment, and potential value of the crop

£ return per m^2 of mini Poinsettia crop compared to a "standard" 13 cm crop

Week	Mini 6 cm 2500 lux	4000 lux	Mini 8 cm 2500 lux	4000 lux	Standard 13 cm unlit
34					32.00
35	47.94	43.93	36.36	32.92	
37	48.06	45.30	37.04	34.32	
38	48.36	45.90	37.36	34.96	

As can be seen from the table the economics of a lit mini branched crop vary with duration and intensity of lighting treatment applied. With lighting at 2500 lux potential returns/m^2 were greater than the "standard" crop especially in 6 cm pots where it was possible to grow plants at closer spacing (60 plants/m^2) compared with 40 plants/m^2 for 8 cm and 16 plants/m^2 for a 'standard' crop. Lighting at 4000 lux while less profitable especially in 8 cm pots, still compared favourably with the standard crop.

DISCUSSION AND CONCLUSIONS

Results from this single trial clearly demonstrated the potential of mini branched *Poinsettia* to not only increase the present product range but to improve potential returns/m^2 over a 'standard' 13 cm crop.

While an unlit control treatment was not assessed it was assumed that supplementary lighting was essential to produce marketable plants from week 35-38 sendings. Lighting at the lower light intensity of 2500 lux proved as successful as the more expensive 4000 lux. Problems were encountered at this higher light level with some chlorosis developing on the 6 cm pot size. This small pot size required great attention to watering and nutrition, with the relatively small volume of media contained proving difficult to maintain in a moist condition. Some stress was evident and this was exacerbated under the higher lighting regime.

With regard to quality of product produced, while week 35 plants were generally scored the best, those from weeks 37 and 38 were only marginally behind and would have obtained a similar price at market. Commercially this would allow for a staggered receipt of plants over a 4 week period, or a single later batch (week 37 or 38) which would cost less to light.

The economic appraisal of the lighting treatments suggest that mini *Poinsettia* could provide higher returns/m^2 than a standard 13 cm crop. Profitability increased at closer spacing (ie. 6 cm pots) and at the lower lighting level of 2500 lux for each date of receipt.

Overall it was felt that with regard to both cultural and economic considerations a lighting level of 2500 lux was more desirable than at 4000 lux. Also, that although the 6 cm pot size represented a greater return/m^2 it proved more difficult to manage than an 8 cm crop. Saleable plants of good quality were possible from all three dates of receipt, and while quality was higher from week 35 compared to week 37 and 38, prices commercially would have been similar.

With regards to shelf life properties plants lit at 2500 lux demonstrated better keeping qualities than those lit at 4000 lux. Also 8 cm pots were easier to maintain in good condition than the 6 cm pot size.

In conclusion the objectives of the trial were successfully achieved with production of a miniature branched *Poinsettia* crop proving both practicable and economically worthwhile with supplementary lighting. The potential benefits to the growers including:

- Savings in production time
- Spread of receipt of plant material
- Reduction in costs per m^2
- and perhaps most importantly the potential for improved returns whilst maintaining consumer interest.

APPENDIX I

Mini Poinsettia

Trial Layout

2500 lux
K3

6 cm wk 35 1	8 cm wk 35 4
6 cm wk 37 2	8 cm wk 37 5
6 cm wk 38 3	8 cm wk 38 6

4000 lux
K6

6 cm wk 35 7	8 cm wk 35 10
6 cm wk 37 8	8 cm wk 37 11
6 cm wk 38 9	8 cm wk 38 12

APPENDIX II

Mini Poinsettia - Mean Height (cm)

Figure 1

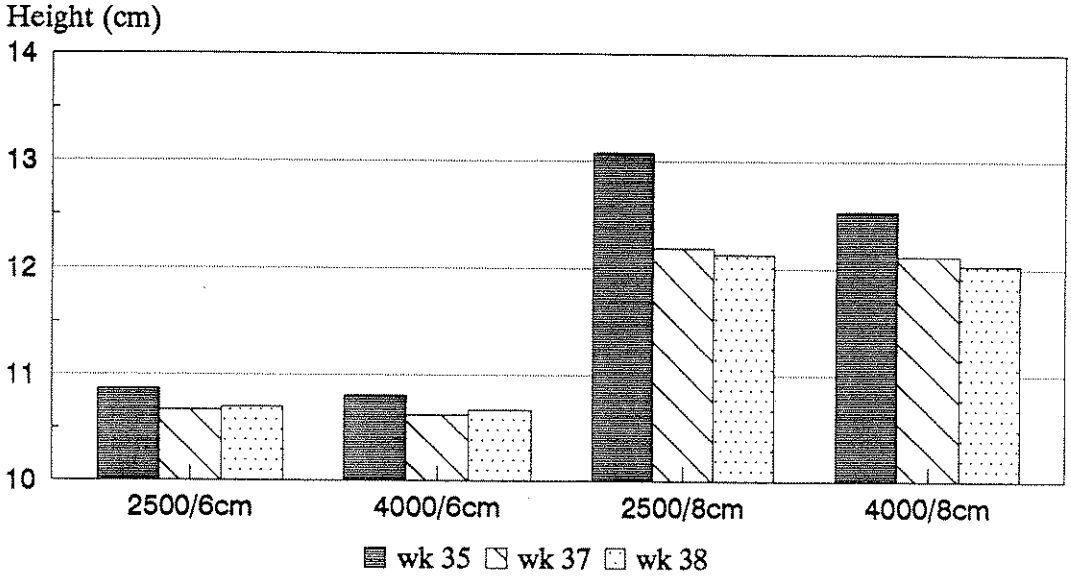


Table 1

	6 cm			8 cm		
	wk 35	wk 37	wk 38	wk 35	wk 37	wk 38
2500 lux	10.9	10.7	10.7	13.1	12.2	12.1
4000 lux	10.8	10.6	10.7	12.5	12.1	12.0

APPENDIX II

Mini Poinsettia - Mean Area of Spread (cm2)
(pi x (ave.spread/2)**2)

Figure 2

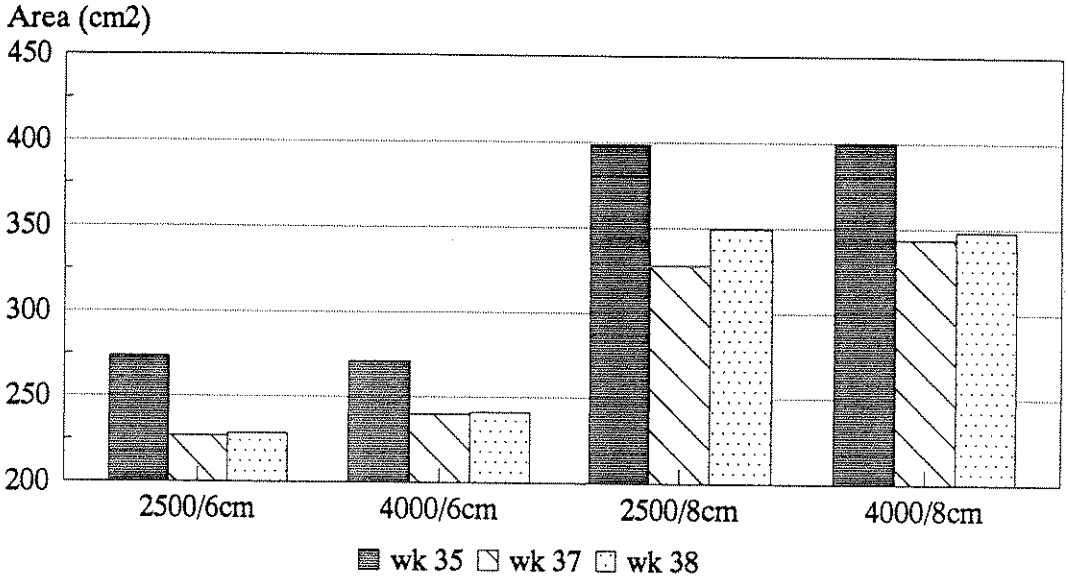


Table 2

	6 cm			8 cm		
	wk 35	wk 37	wk 38	wk 35	wk 37	wk 38
2500 lux	273.8	226.8	228.4	398.2	327.9	349.7
4000 lux	271.0	240.1	241.1	399.7	343.6	347.9

APPENDIX II

Mini Poinsettia - Mean Number of Bracts

Figure 3

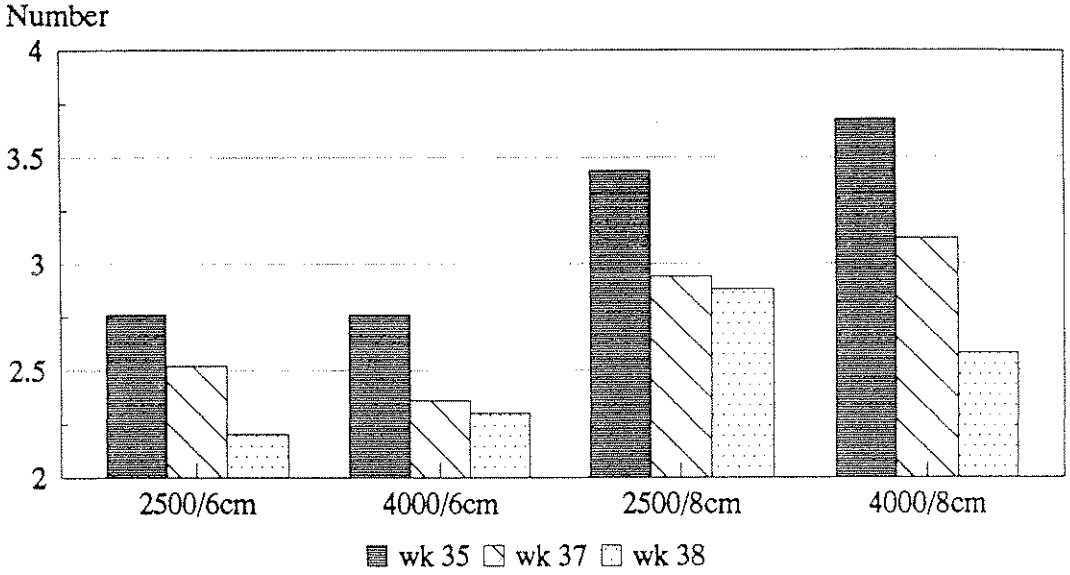


Table 3

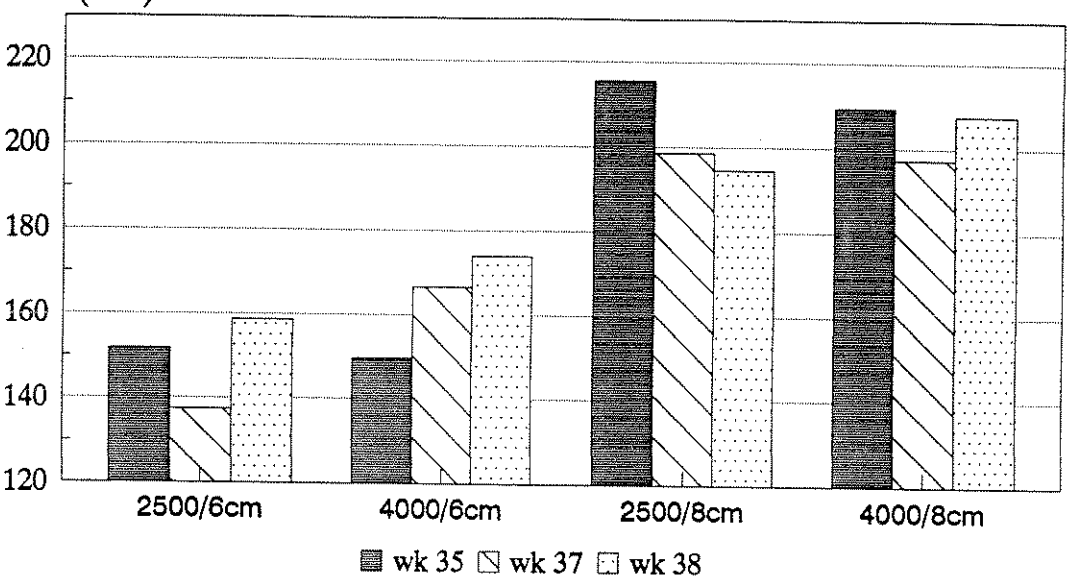
	6 cm			8 cm		
	wk 35	wk 37	wk 38	wk 35	wk 37	wk 38
2500 lux	2.8	2.5	2.2	3.4	2.9	2.9
4000 lux	2.8	2.4	2.3	3.7	3.1	2.6

APPENDIX II

Mini Poinsettia - Mean Area of Bract (cm2)

(pi x (ave.diam/2)**2)

Figure 4



Mini Poinsettia - Mean Bract Diameter (cm)

Table 4

	6 cm			8 cm		
	wk 35	wk 37	wk 38	wk 35	wk 37	wk 38
2500 lux	13.8	13.1	14.1	16.5	15.8	15.6
4000 lux	13.7	14.5	14.8	16.2	15.7	16.1

APPENDIX II

Mini Poinsettia - Mean Quality Score (1 = Best)

Figure 5

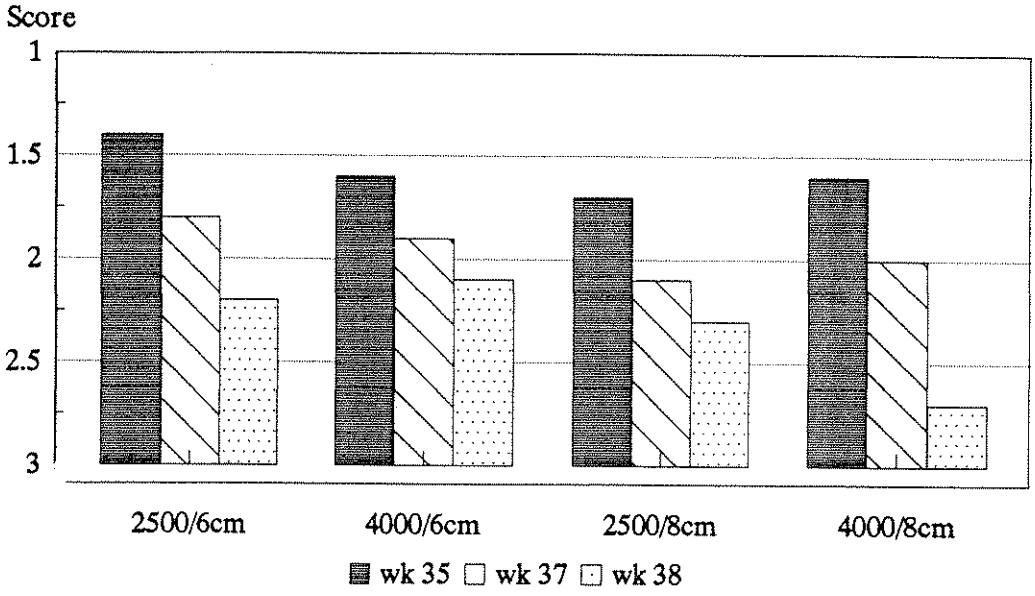


Table 5

	6 cm			8 cm		
	wk 35	wk 37	wk 38	wk 35	wk 37	wk 38
2500 lux	1.4	1.8	2.2	1.7	2.1	2.3
4000 lux	1.6	1.9	2.1	1.6	2.0	2.7

APPENDIX III

Economic appraisal

Notes

1. Capital charges (luminaires, wiring etc) - this is based on an average utilization of between 65 and 85 days, annually depreciated over a 10 year period with interest charges on capital outlay of 14%.

2. Running costs assume that lamps run continuously although in practice on a large installation this might be reduced by turning off lamps during bright periods. 400 W SON/T.

3. The calculations are based on an average rate of 6.8p/kWh (16 hr) and 7.78p/kWh (10 hr) - figures supplied by Electricity Association. Weighted averages accounting for duration of lighting treatment are listed in the calculation.

4. The purchase price of potted rooted cuttings in 1991 was that of rooted cuttings at the peak period of week 34.

5. Spacings: 6 cm pots = 60 plants/m^2
   8 cm pots = 40 plants/m^2
   13 cm pots = 10 plants/m^2

Calculations - running costs (medium/small grower).

Long day and short day periods

Week 35 plants
28 August → 2 October = 36 days (16 hr/day)

Week 37 plants
11 September → 2 October = 22 days (16 hr/day)

Week 38 plants
17 September → 2 October = 16 days (16 hr/day)

All receipts of plants lit from 2 October to 20 November during short day lighting period = 49 days.

Cost of lighting/pot

4000 lux 8 m^2/lamp

Week 35 plants lit at 4000 lux during long day period (assume 3 hours off peak)

$\frac{0.44 \times 16 \times 36 \times 6.0}{8\ m^2}$ = 190p per m^2 of lit bench

Week 35 plants lit at 4000 lux during short day period (assume no off peak)

$\frac{0.44 \times 10 \times 49 \times 4.3}{8\ m^2}$ = 116p per m^2 of lit bench

Total running cost for week 35 plants lit at 4000 lux 190p + 116p = 306p/m^2

For 6 cm pots at 60 plants/m^2 = 5.1p per pot
For 8 cm pots at 40 plants/m^2 = 7.7p per pot

Week 37 plants lit at 4000 lux during long day period (assume 3 hours off peak).

$\frac{0.44 \times 16 \times 22 \times 6.0}{8\ m^2}$ = 116p per m^2 of lit bench

Week 37 plants lit at 4000 lux during short day period (assume no off peak)

$\frac{0.44 \times 10 \times 49 \times 4.3}{8\ m^2}$ = 116p per m^2

Total running cost for week 37 plants lit at 4000 lux 116p + 116p = 232p/m^2

For 6 cm pots at 60 plants/m^2 = 3.9p per pot
For 8 cm pots at 40 plants/m^2 = 5.8p per pot

Week 38 plants lit at 4000 lux during long day period (assume 3 hours off peak)

$\frac{0.44 \times 16 \times 16 \times 6.0}{8\ m^2}$ = 84p per m^2 of lit bench

Week 38 plants lit at 4000 lux during short day period (assume no off peak)

$\frac{0.44 \times 10 \times 49 \times 4.3}{8\ m^2}$ = 116p per m^2 of lit bench

Total running cost for week 38 plants lit at 4000 lux 84p + 116p = 200p/m^2

For 6 cm pots at 60 plants/m^2 = 3.3p per pot
For 8 cm pots at 40 plants/m^2 = 5.0p per pot

2500 lux 13 m^2/lamp

Week 35 plants lit at 2500 lux during long day period (assume 3 hours off peak)

$\frac{0.44 \times 16 \times 36 \times 3.7}{13\ m^2}$ = 72p per m^2 of lit bench

Week 35 plants lit at 2500 lux during short day period (assume no off peak)

$\frac{0.44 \times 10 \times 49 \times 2.6}{13\ m^2}$ = 43p per m^2 of lit bench

Total running cost for week 35 plants lit at 2500 lux 72p + 43p = 115p/m^2

For 6 cm pots at 60 plants/m^2 = 1.9p per pot
For 8 cm pots at 40 plants/m^2 = 2.9p per pot

Week 37 plants lit at 1500 lux during long day period (assume 3 hour off peak)

$\frac{0.44 \times 16 \times 22 \times 3.7}{13\ m^2}$ = 44p per m^2 of lit bench

Week 37 plants lit at 2500 lux during short day period (assume no off peak)

$\frac{0.44 \times 10 \times 49 \times 2.6}{13\ m^2}$ = 43p per m^2 of lit bench

Total running cost for week 37 plants lit at 2500 lux 44p + 43p = 87p/m^2

for 6 cm pots at 60 plants/m^2 = 1.5p per pot
For 8 cm pots at 40 plants/m^2 = 2.2p per pot

Week 38 plants lit at 2500 lux during long day period (assume 3 hours off peak)

$\frac{0.44 \times 16 \times 16 \times 3.7}{13\ m^2}$ = 32p per m^2 of lit bench

Week 38 plants lit at 2500 lux during short day period (assume no off peak

$\frac{0.44 \times 10 \times 49 \times 2.6}{13\ m^2}$ = 43p per m^2 of lit bench

Total running cost for week 38 plants lit at 2500 lux 32p + 43p = 75p/m^2

For 6 cm pots at 60 plants/m^2 = 1.3p per pot
For 8 cm pots at 40 plants/m^2 = 1.9p per pot

Calculations - capital charges

4000 lux = 4.7p/m²/day

	p/pot 6 cm	8 cm
For week 35 crop, lamps in use for 85 days capital cost per m² = £3.99 =	6.7	10.0
For week 37 crop, lamps in use for 71 days capital cost per m² = £3.34 =	5.6	8.4
For week 38 crop, lamps in use for 65 days capital cost per m² = £3.05 =	5.1	7.6

2500 lux = 2.9p/m²/day

For week 35 crop, lamps in use for 85 days capital cost per m² = £2.46 =	4.1	6.2
For week 37 crop, lamps in use for 71 days capital cost per m² = £2.06 =	3.4	5.2
For week 38 crop, lamps in use for 65 days capital cost per m² = £1.88 =	3.1	4.7

Overall cost = running cost + capital cost per pot

4000 lux/week 35/6 cm	= 5.1p + 6.7p	= 11.8p
" 8 cm	= 7.7p + 10.0p	= 17.7p
4000 lux/week 37/6 cm	= 3.9p + 5.6p	= 9.5p
" 8 cm	= 5.8p + 8.4p	= 14.2p
4000 lux/week 38/6 cm	= 3.3p + 5.1p	= 8.4p
" 8 cm	= 5.0p + 7.6p	= 12.6p
2500 lux/week 35/6 cm	= 1.9p + 4.1p	= 6.0p
" 8 cm	= 2.9p + 6.2p	= 9.1p
2500 lux/week 37/6 cm	= 1.5p + 3.4p	= 4.9p
" 8 cm	= 2.2p + 5.2p	= 7.4p
2500 lux/week 38/6 cm	= 1.3p + 3.1p	= 4.4p
" 8 cm	= 1.9p + 4.7p	= 6.6p

Calculated returns per m^2

Assume average prices (1991)

13 cm (standard) crop	=	200p per pot
6 cm crop	=	85p per pot
8 cm crop	=	100p per pot

Value per m^2

For 13 cm crop average spacing = 16 plants/m^2
output value 16 x £2 = £32/m^2

For 6 cm crop average spacing = 60 plants/m^2
output value 60 x £0.85 = £51/m^2

For 8 cm crop average spacing = 40 plants/m^2
output value 40 x £1 = £40/m^2

Any extra returns obtained from the 6 and 8 cm crops must be adequate to cover the additional lighting costs.

For 6 cm crop extra value per m^2 over standard 13 cm crop = £51 - £32 = £19/m^2 or 32p/pot

For 8 cm crop extra value per m^2 over standard 13 cm crop = £40 - £32 = £8/m^2 or 22.5p/pot

A 6 cm crop at 60 plants/m^2 = 32p extra value per pot for which the actual costs of lighting ranges from 4.4p (2500 lux) to 11.8p (4000 lux).

An 8 cm crop at 40 plants/m^2 = 22.5p extra value per pot for which the actual costs of lighting ranges from 6.6p (2500 lux) to 17.7p (4000 lux).

APPENDIX IV

Photographic records

Plate 1. Mini *Poinsettia* - 6 cm pots at sale stage from week 35, 37 & 38 receipt lit at 2500 lux.

Plate 2. Mini *Poinsettia* - 6 cm pots at sale stage from week 35, 37 & 38 receipt lit at 4000 lux.

APPENDIX IV

Plate 3. Mini *Poinsettia* - 8 cm pots at sale stage from week 35, 37 & 38 receipt lit at 2500 lux.

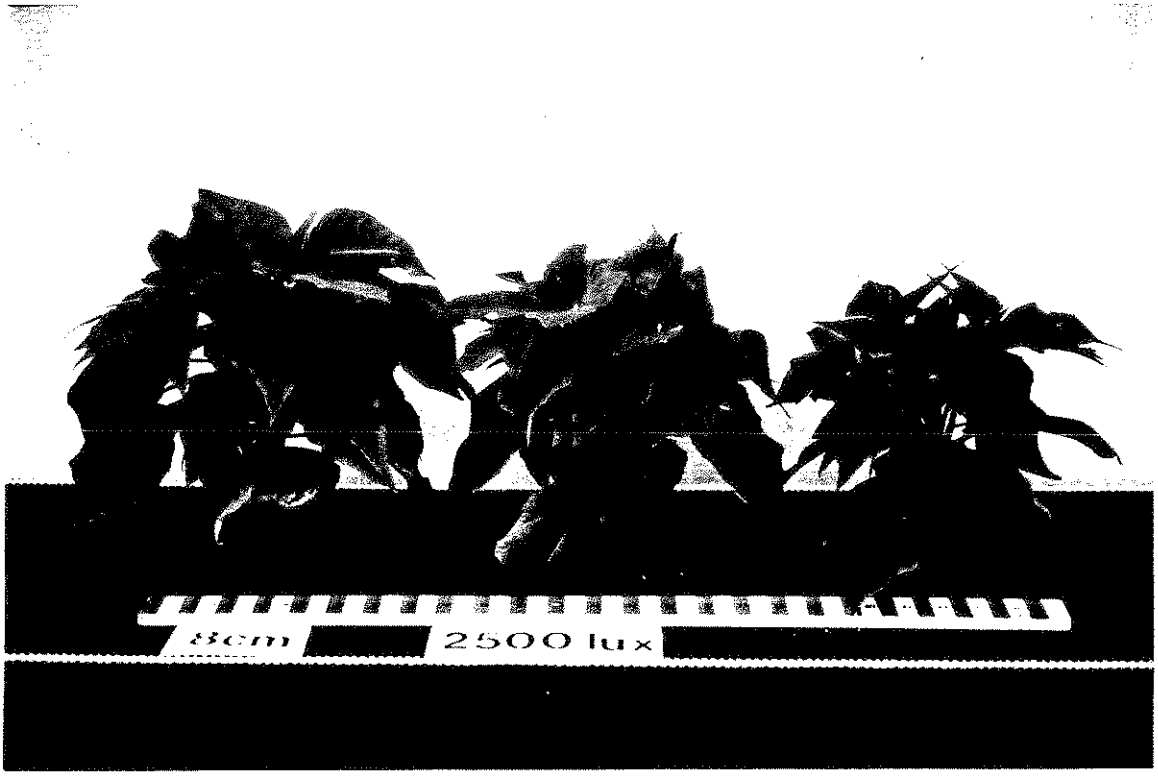
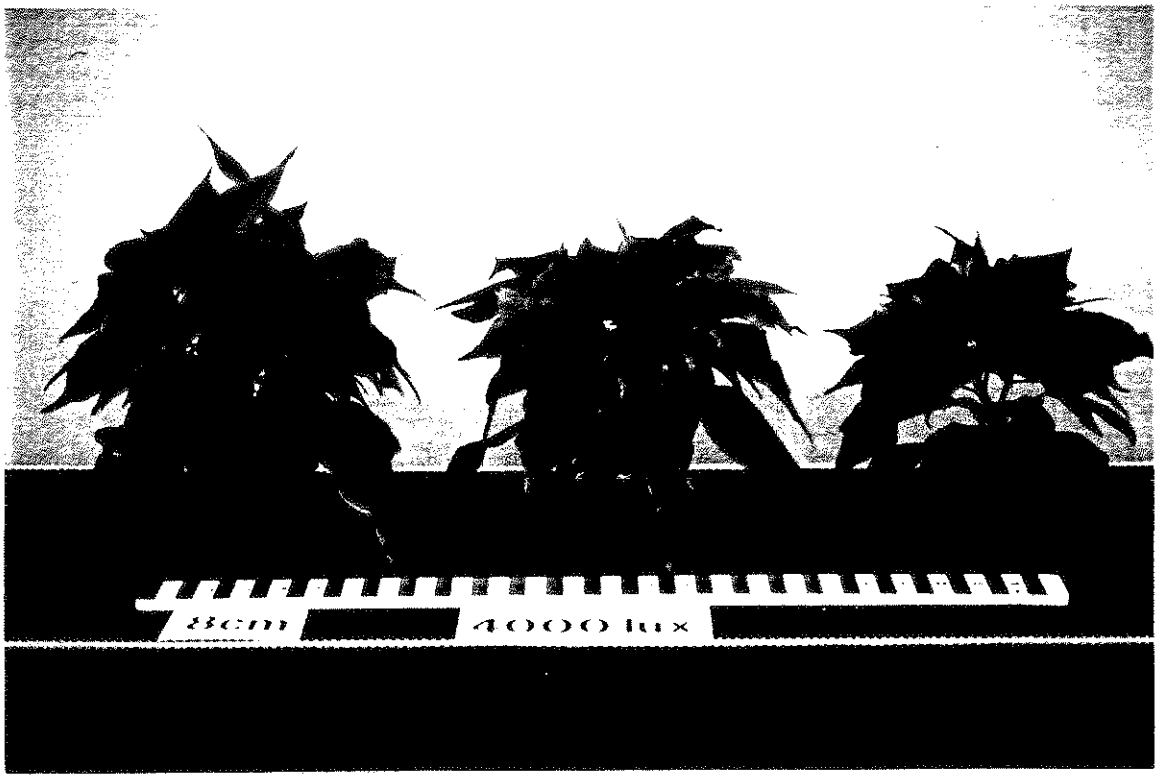


Plate 4. Mini *Poinsettia* - 8 cm pots at sale stage from week 35, 37 & 38 receipt lit at 4000 lux



APPENDIX IV

Plate 5. Chlorosis - 6 cm pot under 4000 lux

Plate 6. Comparison of standard 13 cm crop and 6 and 8 cm mini branched plants