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HDC PC45a

Fuchsia: Improving shelf-life by cultural and chemical means

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

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FINAL CONTRACT REPORT

Fuchsia: Improving shelf-life by cultural and chemical means

HDC PC45a
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RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

APPLICATION

By lighting the Fuchsia cultivars Beacon Rose, Winston Churchill and Miss California to a level of 2500 lux (SON/T) throughout production significant improvements in the speed of production, plant habit and the retention of coloured bud and open flowers were recorded. Clearly, before full application of these results is warranted a full economic appraisal is required to determine the cost benefit of lighting. Although not undertaken within the scope of this report, as a result of the limited number of treatments, comprehensive economic evaluations of supplementary lighting have been made for similar projects on Pot Chrysanthemums (HDC project reports PC13b, 13c, 92 and 92a and their associated factsheet(s)). A component of any economic assessment would be the optimization of plant spacing under lights and hence increased throughput per unit area; spacing was not evaluated in the context of this study.

SUMMARY

In 1992, the HDC commissioned project PC45; Fuchsia: Preliminary trial on the effect of variety on shelf-life properties and the potential for extending shelf-life by cultural or chemical means.

Fuchsia demonstrate relatively poor shelf-life properties such as rapid bud loss, which detracts from their desirability as house plants. Work commissioned through the Horticultural Development Council (HDC) at HRI Efford investigated both cultural and chemical means to improve this aspect of performance on a range of Fuchsia varieties.

1992

Eight varieties were evaluated representing a range of commercially available single, semi-double and double types, 'Swingtime', 'Pink Ballet Girl', 'Marinka', 'La Campanella', 'Winston Churchill' 'Dollar Princess', 'Beacon' and 'Miniros'. Plants were grown under five lighting treatments:

1. Lit 2500 lux, 16 hour/day SON/T lamps
2. Lit 2500 lux, 10 hour/day SON/T lamps
3. Unlit (Control)
4. Lit 100 lux, 16 hour/day GLS lamps
5. Lit 100 lux, 10 hour/day GLS lamps

Prior to marketing, plants were subjected to sub treatments of ± sodium silver thiosulphate spray with the aim of enhancing bud retention. Plants were subsequently transferred to controlled environment facilities after simulated transport to market and sale for a period of shelf-life testing.

Results indicated an advancement of the marketable date where lighting treatments had been applied. Generally, this effect was greater the longer plants were lit each day.

Plant habit under the two lamp types showed marked differences. GLS lit plants became somewhat etiolated, producing fewer flowering shoots. Growth under SON/T was compact with improved shoot number and enhanced colouration of leaves and stems providing a much more 'robust' plant for marketing.

The application of sodium silver thiosulphate prior to marketing produced beneficial effects in shelf-life, with improved flower counts and less bud drop noted. Some varieties appeared more responsive than others, eg. 'Swingtime' where much higher numbers were recorded where STS was applied.

The study was extended for a second year in 1993, and focused on a single lighting treatment of 2500 lux (12 hours/day) throughout production compared to an unlit control with three cultivars, one of which, Winston Churchill, was common to year one.

Beacon Rose - A hardy Fuchsia with an upright habit with single flowers. The flower tube is rather long with rose sepals (petals surrounding the flowers) and deep rose corolla (centre of the flower). Foliage colour darkish green.

Winston Churchill - An upright double flowered type with rose red sepals and a lavender blue with pinkish veined corolla. Foliage colour medium green.

Miss California - An upright semi-double flowered type with light pink sepals and a white corolla. Foliage colour medium green.

Three 'shelf-life' treatments were applied just prior to marketing to further evaluate the degree to which additional buds and flowers may be retained.

Shelf-life chemicals applied prior to marketing: (50% flowering date)

1) Untreated control

2) Sodium silver thiosulphate (Argylene) - treated control

3) Amino-oxyacetic acid (Chrysal EVB) - non-silver ethylene inhibiting compound.

Consistent with the first year's study supplementary lighting accelerated the time to marketing. Specifically, by 28, 23 and 22 days for Beacon Rose, Winston Churchill and Miss California respectively.

Plants lit produced a more compact growth habit and had a larger number of breaks with flowers than unlit crops. The number of coloured buds and open flowers was therefore generally higher. However, again consistent with year one, the magnitude of the response was variety dependent with Winston Churchill having fewer flowers when lit.

The evaluation of flower stickers was inconclusive and to a degree inconsistent with the findings from year one. In 1993 STS results were no better than those of the control in contrast to 1992 where the use of STS significantly increased bud/flower number. However, in 1993 full records could not be made throughout the proposed shelf-life period and hence the results are not directly comparable.

Clearly, as with other crops which share the problem of bud/flower retention *viz.* New Guinea Impatiens, further strategic studies are needed to identify those developmental and/or cultural factors which lead to premature bud and flower loss. Only then can detailed production protocols be evaluated and implemented.

EXPERIMENTAL SECTION

INTRODUCTION

The relatively poor shelf-life properties of Fuchsia are well documented, with bud drop a potentially serious problem during marketing. The use of supplementary lighting, while improving quality and the number of flowers as well as accelerating schedules, can also lead to greater bud drop during marketing with certain varieties as shown in the earlier trial PC45 (year one, 1993). Use of the anti-ethylene compound silver thiosulphate (STS), applied prior to marketing, was shown to reduce the degree of bud drop over a range of varieties, however, there is a question mark over its future availability. Other non-silver anti-ethylene compounds are beginning to appear in response to the need to improve vase-life of cut flowers. Products include Chrysal EVB, Chrysal wholesale (Chrysal-Pokon, Holland) and Florish (Abbot Laboratories, Chicago, USA). Further evaluation of these products is needed to assess their potential to reduce bud drop in crops such as Fuchsia.

The commercial objective of this project was to test ethylene inhibitors for improving shelf-life of a range of Fuchsia cultivars grown with or without supplementary lighting (SON/T AGRO) which were shown to be the better light source in earlier studies; PC45a year one.

Literature Search

Due to the likely long term need for environmentally safe alternatives to the heavy metal containing sodium silver thiosulphate (STS) a literature search was carried out to assess the relevance of other research work which could progress the successful conclusion of this study.

KEY WORDS used for the search through CAB abstracts: Fuchsia, pot plant, anti-ethylene compound, shelf-life, flower abscission, ethylene inhibitor, bud drop, flower drop, flower stickers.

The search highlighted that the main focus of research to date into ethylene inhibition has been on cut flowers in relation to vase-life treatments. Two companies in particular, Chrysal-Pokon BV of Naarden, Holland and Abbott Laboratories, North Chicago, Illinois have carried out work in this area and have introduced materials for cut flowers that inhibit ethylene action. Indeed, the product Chrysal EVB (pre-treatment agent in carnations) is now required by Dutch flower auctions for treating standard and mini carnations. The Dutch government regulate tightly the use and disposal of STS and it is reasonable to assume that European legislation could soon be passed to make this the case in the UK.

Based on studies conducted in Holland, Chrysal EVB (amino-oxyacetic acid of AOA) allows more buds to open on flowering plants and increases cut flower longevity equal to or greater than that observed for silver compounds. However, the results emphasize that it is variable in its performance, for example, it works better on spray carnations than on standard carnations. Following further discussion with manufacturers a sample was released for trialling to see if these beneficial effects could be observed with flowering pot plants. However, it was stated that limited observations in Holland on Rieger Begonia had not proved successful (pers comm). Work carried out at Michigan State University, USA using AOA on pot New Guinea Impatiens showed that plants pretreated with AOA or STS and subjected to simulated shipping performed similarly, (in reducing corolla abscission to 20%), when compared with an untreated control. The potential of AOA on pot Fuchsia plants could well be as useful in reducing the degree of bud drop as was shown for STS in year one of the trial.

A complete cut flower preservative, Florish, was launched by Abbot Laboratories in the USA in 1992. It contains a natural fermentation metabolite that inhibits ethylene biosynthesis in plant tissues. It is currently recommended for use on carnations and mixed bouquets containing ethylene sensitive cut flowers and foliage. However, there is little performance data available for pot plants.

Other products that have shown potential in extending vase-life include Abscisic acid, Nickel Chloride and Sucrose. Abscisic acids rôle in bud/flower drop appears to be varied between species, much of the work indicated problems in the extraction and purification techniques used to obtain this naturally occurring plant growing regulator. Abscisic acid also tends to break down rapidly and responds differently to specific modes of application (i.e. via roots, foliar spray, stem injection etc.) and it appears that much strategic research needs still to be conducted before any commercial application could be developed for pot plants (pers comm between L Sach and plant physiologists from Manchester University, Nottingham University and Reading University). Research in India has shown that Nickel Chloride and Sucrose can increase gladioli vase-life. However, the use of Nickel Chloride tends to change flower petal colour, particularly pinks to creams which would pose a problem to the majority of Fuchsia varieties and therefore would not provide a satisfactory alternative to STS.

References:

Abbott Laboratories product literature

Anon (1992) Non silver anti-ethylene compounds Grower Talks August 1992

Dorstal, D L; et al. (1991) Ethylene, simulated shipping, STS and AOA affect corolla abscission of New Guinea Impatiens. PPGA News July 1991

Murali, T P; Reddy, T V; (1992) Increase gladioli vase-life with Nickel Chloride and Sucrose. Ohio Florist Association Bulletin No 26

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OBJECTIVES

- To establish the varietal response and shelf-life characteristics of a range of Fuchsia cultivars when subjected to lighting during production and the application of 'flower sticking' chemicals prior to shelf-life.

- To improve shelf-life performance by preventing rapid flower and bud abscision.

MATERIALS AND METHODS

Site

The plants were grown on ebb and flow benches covered with microperforated black plastic over capillary matting. Four compartments of the multifactorial glasshouse "K" Block at HRI Efford, were used each compartment having a separate lighting treatment.

Cultivars

The plants for the trial were brought in from Royal Eveleens as rooted cuttings on 14 January 1993.

Three widely grown commercial cultivars with different flower types, but suitable for pot plant production were chosen following discussion with the Chairman of the British Bedding and Pot Plant Association (BBPPA) Fuchsia and Pelargonium Group and H M Kitchener, pot plant consultant, ADAS. The cultivars selected are detailed as follows:

Beacon Rose - A hardy Fuchsia with an upright habit with single flowers. The flower tube is rather long with rose sepals (petals surrounding the flowers) and deep rose corolla (centre of the flower). Foliage colour darkish green.

Winston Churchill - An upright double flowered type with rose red sepals and a lavender blue with pinkish veined corolla. Foliage colour medium green.

Miss California - An upright semi-double flowered type with light pink sepals and a white corolla. Foliage colour medium green.

Treatments

Lighting Treatments

1) Unlit

2) Lit 2500 lux using SON/T AGRO lamps for 12 hours/day throughout production

Shelf-life Treatments

Shelf-life chemicals applied prior to marketing: (50% flowering date)

1) Untreated control

2) Sodium silver thiosulphate (Argylene) - treated control

3) Amino-oxyacetic acid (Chrysal EVB) - non-silver ethylene inhibiting compound.

Experimental design

4	main plots (2 lighting x 2 replicates)
x	
3	replicates within compartment
12	sub-plots
x	
4	shelf-life treatments within each sub-plot at marketing
36	plots/variety
x	
3	varieties
108	plots in total

Plot size: 13 plants per plot at pot thick stage
8 plants per plot at full spacing

Cultural Details

Potting: Plants were potted in to 10F terracotta Optipots (2 tier drainage) using Fisons Levington M2 on 15 January 1993. All cultivars were pinched to three pairs of true leaves so that any treatment effects could be more readily compared when starting with uniform plant material. Winston Churchill cuttings were pinched at potting, Miss California three days later and Beacon Rose ten days after potting. Once laid out pot thick in the compartments the plants were given a drench of propamocarb hydrochloride (Filex) and tolclofos-methyl (Basilex) as a tank mix (10 ml Filex and 2 g Basilex) in sufficient water to thoroughly wet the root zone to protect against root rots.

Temperatures: The compartment temperatures were set at 16°C day/night across all treatments. Venting commenced at 18°C.

Lighting: Lighting treatments were applied from potting until coloured buds were well established on plants.

Pest and disease control: Due to the cold humid weather during the trial disease control was important. A preventative treatment of iprodione (Rovral 0.5 g/l) against *Botrytis* was applied on 2 February. A further spray appeared on 24 February followed by an application of chlorothalonil (Repulse at 2.2 ml/l) on 6 April. Despite this fungicide programme being followed and the crop being spaced in line with commercial practice to lower the humidity in the immediate vicinity of the plant, losses were recorded due to *Botrytis* and *Cylindrocarpon destructans*; the cultivar Beacon Rose appeared to be particularly susceptible to the latter. However, the number of plants lost was not initially statistically significant and did not affect the conduct of the first phase of the trial.

Weekly introductions were made of the biological control agents *Aphidoletes aphidomyza*, *Encarsia formosa* and *Phytoseiulus persimilis* for the control of aphids (*Aphididae*), glasshouse whitefly (*Trialeurodes vaporariorum*) and two-spotted spider mite (*Tetranychus urticae*). Introductions of *Amblyseius cucumeris* for the control of western flower thrips (*Franklinella occidentalis*) were made at three weekly intervals.

Spacing: The plants were given an intermediate spacing of 16 cm x 16 cm (40 pots per m^2) with a final spacing of 24 cm x 24 cm (17 pots per m^2).

Nutrition: Liquid feed was applied at every watering from two weeks after potting. The ADAS recommended feed supplied 150 ppm N, 100 ppm P_2O_5 and 150 ppm K_2O from the following stock feed:

Material	**g/l**
Ammonium nitrate	35
Monoammonium phosphate	75
Potassium nitrate	79

A dilution of 1 in 200 gave a conductivity of 1375 μS cm^{-1} above the background water conductivity. (HRI Efford water supply approximately 650 μS cm^{-1}).

Plant growth regulation: A standard plant growth regulator regime was followed using Cycocel and Bonzi as per ADAS recommendations. The following treatments were applied to all cultivars.

Table 1 Plant Growth Regulator; date of application

Lit compartments:	
Cycocel at 1.5 ml/l + Spreader 0.5 ml/l	15/02/93, 05/03/93 and 12/03/93
Unlit compartments:	
Cycocel at 1.5 ml/l + Spreader 0.5 ml/l	15/02/93, 19/03/93, 05/04/93 and 20/04/93
Bonzi at 1.25 ml/l	28/04/93

The shelf-life chemical treatments (flower stickers) were applied to the appropriate plots as follows:

Table 2 Shelf-life Chemical Treatments; date of application

Chrysal applied at 5 ml/l	26/03/93 (lit)
Chrysal applied at 2.5 ml/l*	02/04/93 (lit) and 08/04/93 (lit) 06/05/93 (unlit) and 12/05/93 (unlit)
Argylene applied at 1 g/l	26/03/93 (lit) and 06/05/93 (unlit)

Anti-ethylene compounds were applied as per label recommendations

* *The rate of Chrysal used was half that proposed due to the 5 ml/l rate causing some undesirable yellowing in the tip of the cultivar Winston Churchill which the plants grew out of in about 5 days. The 2.5 ml/l rate did not appear to have any detrimental effects.*

Assessments

Throughout the course of the trial , records were made on plant development including plant habit, bud and flower development. The time to 50% flowering was recorded.

At Marketing

At the point of marketing, when at least 2 flowers per plant were fully open, full assessments of the following were made:

- Plant size score (6 = tallest; 1 = shortest)
- Number of flowering breaks
- Number of coloured buds
- Number of open flowers

Shelf-life

It was proposed that six plants for each plot were sleeved, boxed and transported to Birmingham and back to simulate a market run. On their return the sleeves would have been removed and the plants placed in shelf-life conditions of 20°C and 1000 lux for a 12 hour day.

Unfortunately, whilst it proved possible to establish the point at which plants were considered marketable the general condition of the crop precluded its further evaluation under shelf-life conditions. Refer to the results section for a fuller explanation.

Statistical analysis and explanation of statistical terms

Experimental records at the marketing stage were subjected for Analysis of Variance in order that statistical significance could be assigned to treatment differences.

Throughout the main body of this report and selected appendices a number of statistical terms are referred to; these are:

SED	=	The standard error of the difference when comparing two means in that column of data.

A statistical term easier to interpret:

LSD 5%	=	The least (minimum) difference when comparing two means within a given column that is required for the means to be statistically different.
N.S.	=	Not Significant.
*	=	$P<0.05$, i.e. the probability of this result occurring by chance is equal to or less than 1 in 20 (0.05 = 5%)
**	=	$P<0.01$, i.e. the probability of this result occurring by chance is equal to or less than 1 in 100 (0.01 = 1%)
***	=	$P<0.001$, i.e. the probability of this result occurring by chance is equal to or less than 1 in 1000 (0.001 = 0.1%)

RESULTS

Early Growth

All unlit varieties grew very slowly during the first four weeks from potting on. This could be partly explained by the poor natural light levels.

Due to the cold humid weather during the experiment, growth control was particularly important. It was comparatively difficult to keep the compost dry and this factor combined with the poor light levels meant that several applications of Cycocel were used during the trial (Table 1, page 11). Treatment effects due to the lighting regime were seen early on with the lit plants showing quicker establishment and development, producing longer breaks, more pairs of true leave per break and more breaks from the base of the plant. However, there was no lighting effect on the number of breaks from the top as illustrated below in Table 3.

Table 3 The effect of lighting treatments on break lengths, number of breaks and number of pairs of true leaves per break (measured on 15.02.93)

	Break length (cm)	No. of breaks		Pairs of true leaves/break
		From top	From base	
Lit plants:				
Beacon Rose	4	2	4	3
Winston Churchill	5	2	3	3
Miss California	4	2	3	4
Unlit plants:				
Beacon Rose	2	2	2	2
Winston Churchill	3	2	2	2
Miss California	3	2	2	3

The first visible buds were seen on Beacon Rose and Winston Churchill in the lit compartments during week 11. The time taken to 50% flowering (Appendix II, page 25) showed that lighting at 2500 lux for 12 hours considerably accelerated plant growth and development; at this growth stage lit plants were 28 days, 23 days and 22 days ahead for Beacon Rose, Winston Churchill and Miss California respectively. The use of the anti-ethylene compounds had no effect on the time taken to 50% flowering as would be expected since the treatments had just been applied.

Assessments at Marketing

Tabular results for the effects of lighting and flower sticker treatments on various growth and flowering parameters are presented in tables 7 to 12 (Appendix III, pages 26 to 28).

Plant height

Plant height at marketing was significantly affected by the use of supplementary lighting ($P = 0.003$) with all varieties responding similarly. The unlit crop was taller with an average height score of 5.34, the lit crop shorter at 4.41. Reflecting differing growth habits, plant height also varied with cultivar with Miss California the tallest (5.14) and Winston Churchill the shortest (4.44).

Number of flowering breaks

The number of breaks with flowers was also significantly influenced by the lighting treatment ($P = 0.016$) although this showed a strong interaction with cultivar, (Table 4; $P = 0.001$) in that the cultivar Winston Churchill had fewer breaks when lit during production.

Table 4 The effect of lighting on the number of breaks with flowers

	Unlit		**Lit (2500 lux)**
Beacon Rose	4.6		6.1
Winston Churchill	5.5		4.6
Miss California	5.2		5.5
SED (d.f = 60)	*0.34*	*0.28**	*0.34*
LSD 5%	*0.74*	*0.61**	*0.74*

* *Figures to be used when comparing between lighting treatments*

The application of flower stickers had no effect on the number of flowering breaks.

Number of coloured buds

Despite the fact that chemical treatments were applied shortly before marketing their use had a highly significant effect on coloured bud number ($P<0.001$). However, this too showed a marked varietal interaction and also whether the crop had been lit during production, table 5.

Table 5 Effect of shelf-life chemicals on the number of coloured buds

	Shelf-life chemicals		
	Control	**EVB**	**STS**
Lit (2500 lux)			
Beacon Rose	28.4	28.5	28.8
Winston Churchill	16.5	13.8	17.4
Miss California	26.3	15.9	24.7
Unlit			
Beacon Rose	17.8	13.6	14.5
Winston Churchill	7.2	5.4	8.3
Miss California	8.9	6.3	9.6

SED (d.f = 60) = 3.25
LSD 5% = 7.08

In general, lighting significantly increased the number of buds. However, the use of flower 'stickers' was inconsistent in that EVB reduced the average number of buds to 14 (averaged over all treatments), three buds less than the control. The use of STS gave results comparable to the control. The cultivar Winston Churchill had fewer buds throughout.

Number of open flowers

The number of open flowers, as with buds, was shown to be a function of cultivar which in turn displayed a strong intreaction with the lighting treatment, table 6 ($P<0.001$).

Table 6 Effect of lighting on the number of open flowers

	Unlit		Lit (2500 lux)
Beacon Rose	16.0		22.0
Winston Churchill	10.5		4.2
Miss California	11.7		10.3
SED (d.f. = 60)	0.92	0.66*	0.92
LSD 5%	2.00	1.44*	2.00

Cultivar Beacon Rose produced more open flowers when lit during production. In contrast Miss California showed little response and Winston Churchill produced approximately half the number of open flowers when lit.

As with the bud number the use of EVB reduced the flower count to a level below that of the control, 10.9 and 13.0 respectively. The use of STS gave results comparable to the control.

Shelf-life Assessments

An objective of this trial was to evaluate the possible benefits of pre-marketing applications of 'flower sticking' chemicals during a three week shelf-life assessment. However, a number of factors prohibited the completion of this phase of the study. Firstly, although Cycocel was used to give growth control, (standard commercial practice), it's use was restricted to avoid confounding the effects of the experimental treatments, specifically lighting, which was itself likely to influence plant habit. A consequence of this was that many of the plants were not considered to be of marketable quality and hence shelf-life assessment would be inappropriate. Secondly, despite rigorous efforts to control *Botrytis* a considerable number of plants had been lost by the end of the trial.

In conclusion whilst some of the initail observations, on the use of flower stickers (just prior to marketing) were consistant with year one, further evaluation in shelf-life for the reasons specified above would not have been sufficiently robust for inclusion in the final report.

DISCUSSION AND CONCLUSIONS

A number of Fuchsia cultivars have shown potential for early season pot production having compact erect habits, and a range of foliage and flower colour types. In the second year of this study the cultivars evaluated have demonstrated this once again although results suggest that lighting during growth is a prerequisite for early production.

Interpretation of the results from this trial should be undertaken with care. Both this study and that of the preceding year have demonstrated that the cultivar response in Fuchsia is highly variable under differing cultural conditions; only three cultivars were evaluated here (eight in 1992).

Consistent with 1992 (year one PC45a) was the result that lighting advanced the date at which plants were considered marketable hence shortening the production period affording earlier sales and/or a greater throughput of crops. Specifically, lit plants were 28 days, 23 days ahead of unlit plants in the cultivars Beacon Rose, Winston Churchill and Miss California respectively.

Lighting with SON/T lamps produced a much more acceptable plant shape and habit, a result which was entirely consistent with the first year's study. The unlit crop was generally taller, having been stretched by the low ambient winter light levels that prevailed during the experiment. The number of flowering breaks was also increased where the crop was lit throughout production.

Consistent with year one, lighting was also shown to increase the number of coloured buds and open flowers at marketing. Again as with earlier studies this response was shown to be highly cultivar dependent.

In conclusion:

- On average lighting (2500 lux throughout production) advanced the marketable date by 3 to 4 weeks for the three cultivars evaluated.

- Lighting increased the number of flowering breaks and hence plant habit.

- Lighting increased the number of coloured buds and open flowers at and immediately post marketing.

- The use of 'flower stickers' was inconclusive. Indeed the use of EVB appeared to reduce flower and bud number. Further work is needed in this area.

APPENDICES

APPENDIX I

Crop Diary; Compartment K2 (lit)

Date	Operation undertaken
15.1.93	Potted up and put in compartments Lighting treatment started 12 hrs 7.30-7.30
15.1.93	Winston Churchill pinched
18.1.93	Miss California pinched
21.1.93	Drench - Filex 250 ml + Basilex 50 g^{-1} in 132 l^{-1} of water
25.1.93	Beacon Rose pinched
2.2.93	Rovral applied at rate of 0.5 g^{-1}/l^{-1}
3.2.93	Feed started
15.2.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader at 0.5 ml^{-1}/l^{-1}; except Beacon Rose
16.2.93	All three varieties first spacing
19.2.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader at 0.5 ml^{-1}/l^{-1} to Beacon Rose
24.2.93	Rovral applied at 1 g^{-1} per l^{-1} on all three varieties
1.3.93	Second spacing on all three varieties
5.3.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader 0.1 ml^{-1}/l^{-1} on all varieties
12.3.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader 0.1 ml^{-1}/l^{-1} on all varieties
26.3.93	Argylene applied at rate of 1 g^{-1} per l^{-1} on all varieties
30.3.93	Third spacing of all three varieties
2.4.93	Chrysal applied at rate of 5 ml^{-1} per l^{-1} on all varieties
5.4.93	Repulse applied at rate of 2.2 ml^{-1} per l^{-1} on all varieties
8.4.93	Benlate applied at rate of 0.5 g^{-1} per l^{-1} on all varieties
8.4.93	Chrysal EVB applied at rate of 2.5 ml^{-1}/l^{-1} on all varieties
14.4.93	Chrysal EVB applied at rate of 2.5 ml^{-1}/l^{-1} on all varieties
14.4.93	Argylene applied at rate of 1 g^{-1}/l^{-1} on all varieties

APPENDIX I

Crop Diary; Compartment K7 (unlit)

Date	Operation undertaken
15.1.93	Potted up and put in compartments
15.1.93	Winston Churchill pinched
18.1.93	Miss California pinched
21.1.93	Drench - Filex 250 ml + Basilex 50 g^{-1} in 132 l^{-1} of water.
25.1.93	Beacon Rose pinched
2.2.93	Rovral applied at rate of 0.5 g^{-1}/l^{-1}
3.2.93	Feed started
10.2.93	One Beacon Rose died. Replaced with spare
15.2.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader at 0.5 ml^{-1}/l^{-1}. Beacon Rose not sprayed
16.2.93	All three varieties first spacing
19.2.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader at 0.5 ml^{-1}/l^{-1} - Beacon Rose
24.2.93	Rovral applied at 1 g^{-1} per l^{-1} on all three varieties
15.3.93	One Winston Churchill died. Replaced with spare
19.3.93	Repulse applied at rate of 2.2 ml^{-1}/l^{-1}
22.3.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader 0.5 ml^{-1}/l^{-1} on all varieties
4.4.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader 0.5 ml^{-1}/l^{-1} on all varieties
5.4.93	Repulse applied at rate of 2.2 ml^{-1} per l^{-1} on all varieties
7.4.93	All three varieties second spacing
8.4.93	Benlate applied at rate of 0.5 g^{-1} per l^{-1} on all varieties
14.4.93	Argylene applied at rate of 1 g^{-1}/l^{-1} on all varieties
14.4.93	Chrysal EVB applied at rate of 2.5 ml^{-1}/l^{-1} on all varieties
20.4.93	Chrysal EVB applied at rate of 2.5 ml^{-1}/l^{-1} on all varieties
20.4.93	Cycocel applied at rate of 1.5 ml^{-1}/l^{-1} + spreader 0.5 ml^{-1}/l^{-1} on all varieties
28.4.93	Repulse applied at rate of 2.2 ml^{-1} per l^{-1} on all varieties
28.4.93	Chrysal EVB applied at rate of 2.5 ml^{-1}/l^{-1} on all varieties
28.4.93	Repulse applied at rate of 2.2 ml^{-1}/l^{-1} on all varieties
28.4.93	Chrysal EVB applied at rate of 2.5 ml^{-1}/l^{-1} on all varieties
1.5.93	Bonzi 1.25 ml^{-1}/l^{-1}
6.5.93	Chrysal EVB applied on all varieties at rate of 2.5 ml^{-1}/l^{-1}
6.5.93	Argylene applied at rate of 1 g^{-1}/l^{-1} on all varieties
12.5.93	Chrysal EVB applied at rate of 2.5 ml^{-1}/l^{-1} on all varieties

APPENDIX I

Crop Diary; Compartment K12 (unlit)

Date	Operation undertaken
15.1.93	Potted up and put in compartments
15.1.93	Winston Churchill pinched
18.1.93	Miss California pinched
19.1.93	Evening out Beacon Rose
21.1.93	Drench - Filex 250 ml + Basilex 50 g^{-1} in 132 l^{-1} of water.
25.1.93	Beacon Rose pinched
2.2.93	Rovral applied at rate of 0.5 g^{-1}/l^{-1}
3.2.93	Feed started
10.2.93	One Beacon Rose died. Replaced with spare
15.2.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader at 0.5 ml^{-1}/l^{-1}. Beacon Rose not sprayed
16.2.93	All three varieties first spacing
19.2.93	Sprayed Cycocel at 1.5 ml^{-1}/l^{-1} + spreader at 0.5 ml^{-1}/l^{-1} on Beacon Rose
24.2.93	Sprayed Rovral at 1 g^{-1} per l^{-1} on all three varieties
19.3.93	Repulse applied at rate of 2.2 ml^{-1}/l^{-1}
22.3.93	Sprayed Cycocel at 1.5 ml^{-1}/l^{-1} + spreader 0.5 ml^{-1}/l^{-1} on all varieties
5.4.93	Sprayed Cycocel on all three varieties at rate of 1.5 ml^{-1}/l^{-1} + spreader 0.5 ml^{-1}/l^{-1}
5.4.93	Repulse applied at rate of 2.2 ml^{-1} per l^{-1} on all varieties
7.4.93	All three varieties second spacing
7.4.93	Two Beacon Rose died and replaced with spares
8.4.93	Sprayed Benlate at rate of 0.5 g^{-1} per l^{-1} on all varieties
14.4.93	Sprayed Argylene applied at rate of 1 g^{-1}/l^{-1} on all varieties
14.4.93	Sprayed Chrysal EVB at rate of 2.5 ml^{-1}/l^{-1} on all varieties
20.4.93	Sprayed Cycocel at rate of 1.5 ml^{-1}/l^{-1} + spreader 0.5 ml^{-1}/l^{-1} on all varieties
20.4.93	Sprayed Chrysal EVB at rate of 2.5 ml^{-1}/l^{-1} on all varieties
28.4.93	Bonzi spray at 1.25 ml^{-1}/l^{-1} on all varieties
28.4.93	Sprayed Repulse at rate of 2.2 ml^{-1}/l^{-1} on all varieties
28.4.93	Sprayed Chrysal EVB at rate of 2.5 ml^{-1}/l^{-1} on all varieties
6.5.93	Sprayed Chrysal EVB at rate of 2.5 ml^{-1}/l^{-1} on all varieties
6.5.93	Sprayed Argylene at rate of 1 g^{-1}/l^{-1} on all varieties
12.5.93	Sprayed Chrysal EVB at rate of 2.5 ml^{-1}/l^{-1} on all varieties

APPENDIX I

Crop Diary; Compartment K13 (lit)

Date	Operation undertaken
15.1.93	Potted up and put in compartments Lighting treatment started 12 hrs 7.30 - 7.30
15.1.93	Winston Churchill pinched
18.1.93	Miss California pinched
19.1.93	Evening out Beacon Rose
21.1.93	Drench - Filex 250 ml + Basilex 50 g^{-1} in 132 l^{-1} of water.
25.1.93	Beacon Rose pinched
2.2.93	Rovral applied at rate of 0.5 g^{-1}/l^{-1}
3.2.93	Feed started
15.2.93	Cycocel applied at 1.5 ml^{-1}/l^{-1} + spreader at 0.5 ml^{-1}/l^{-1}. Beacon Rose not sprayed
16.2.93	All three varieties first spacing
19.2.93	Sprayed Cycocel at 1.5 ml^{-1}/l^{-1} + spreader at 0.5 ml^{-1}/l^{-1} on Beacon Rose
24.2.93	Sprayed Rovral at 1 g^{-1} per l^{-1} on all three varieties
1.3.93	Second spacing on all three varieties
5.3.93	Sprayed Cycocel at 1.5 ml^{-1}/l^{-1} + spreader at 0.1 ml^{-1}/l^{-1} on all varieties
12.3.93	Sprayed Cycocel at 1.5 ml^{-1}/l^{-1} + spreader at 0.1 ml^{-1}/l^{-1} on all three varieties
19.3.93	Sprayed Repulse at rate of 2.2 ml^{-1}/l^{-1}
26.3.93	Sprayed Argylene at rate of 1 g^{-1} per l^{-1} on the seventh and eighth rows of all varieties
26.3.93	Sprayed Chrysal EVB at rate of 5 ml^{-1} per l^{-1} on all varieties
30.3.93	Third spacing of all three varieties
2.4.93	Sprayed Chrysal at rate of 5 ml^{-1}/l^{-1} on all varieties
5.4.93	Sprayed Repulse at rate of 2.2 ml^{-1} per l^{-1} on all varieties
6.4.93	Two Beacon Rose died of *Cladosporum*.
8.4.93	Sprayed Benlate at rate of 0.5 g^{-1} per l^{-1} on all varieties
8.4.93	Sprayed Chrysal EVB at rate of 2.5 ml^{-1}/l^{-1} on all varieties
14.4.93	Sprayed Argylene applied at rate of 1 g^{-1}/l^{-1} on all varieties
14.4.93	Sprayed Chrysal EVB at rate of 2.5 ml^{-1}/l^{-1} on all varieties

APPENDIX II

Table 7 **The effect of lighting treatments and shelf-life chemicals on the time to 50% flowering**

(Dates are expressed as Collins dates and are the date upon which four of the eight plants per plot had two or more open flowers)

	Shelf-life chemicals		
	Control	**EVB**	**STS**
Lit (2500 lux)			
Beacon Rose	111	110	111
Winston Churchill	107	107	105
Miss California	110	108	109
Unlit			
Beacon Rose	139	138	138
Winston Churchill	129	131	130
Miss California	131	135	130

APPENDIX III

Table 8

Effect of lighting and chemical flower sticker treatments on height score (1-6) at marketing

	Shelf-life chemicals		
	Control	EVB	STS
Lit (2500 lux)			
Beacon Rose	4.62	4.45	4.69
Winston Churchill	4.29	3.67	4.29
Miss California	4.77	4.37	4.54
Unlit			
Beacon Rose	5.46	5.21	5.50
Winston Churchill	4.83	4.60	4.96
Miss California	5.65	5.73	5.81

Table 9

Effect of lighting and chemical flower sticker treatments on the number of flowering breaks at marketing

	Shelf-life chemicals		
	Control	EVB	STS
Lit (2500 lux)			
Beacon Rose	6.09	6.09	6.12
Winston Churchill	4.81	4.46	4.66
Miss California	5.54	5.48	5.54
Unlit			
Beacon Rose	4.60	4.48	4.67
Winston Churchill	5.62	5.33	5.69
Miss California	5.25	5.10	5.15

APPENDIX III

Table 10

Effect of lighting and chemical flower sticker treatments on the number of coloured buds at marketing

	Shelf-life chemicals		
	Control	EVB	STS
Lit (2500 lux)			
Beacon Rose	28.4	28.5	26.8
Winston Churchill	16.5	13.8	17.4
Miss California	26.3	15.9	24.7
Unlit			
Beacon Rose	17.8	13.6	14.5
Winston Churchill	7.2	5.4	8.3
Miss California	8.7	6.3	9.6

Table 11

Effect of lighting and chemical flower sticker treatments on number of open flowers at marketing

	Shelf-life chemicals		
	Control	EVB	STS
Lit (2500 lux)			
Beacon Rose	22.5	18.5	25.2
Winston Churchill	4.1	3.9	4.4
Miss California	11.5	8.3	11.0
Unlit			
Beacon Rose	18.2	14.8	15.3
Winston Churchill	10.4	9.8	10.9
Miss California	11.7	10.0	13.6

APPENDIX III

Table 12

Effect of lighting and chemical flower sticker treatments on overall quality score (1-3) at marketing

	Shelf-life chemicals		
	Control	EVB	STS
Lit (2500 lux)			
Beacon Rose	2.54	2.39	2.71
Winston Churchill	2.50	2.23	2.44
Miss California	2.94	2.46	2.71
Unlit			
Beacon Rose	2.91	2.89	2.89
Winston Churchill	2.92	2.92	2.96
Miss California	2.79	2.87	2.92

APPENDIX IV

Photographic plates of cvs Winston Churchill and Miss California at marketing

Winston Churchill

Miss California

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

PROPOSAL

1. TITLE OF PROJECT

Contract No: PC/45a
(Extension for a second season)
Contract date: 2.4.93

FUCHSIA: EFFECT OF VARIETY ON SHELF LIFE PROPERTIES AND THE POTENTIAL FOR EXTENDING SHELF LIFE WITH CULTURAL AND CHEMICAL MEANS

2. BACKGROUND AND COMMERCIAL OBJECTIVE

The relatively poor shelf life properties of *Fuchsia* are well documented, with bud drop a potentially serious problem during marketing. The use of supplementary lighting, while improving quality and degree of flowering as well as accelerating schedules, can also lead to greater bud drop during marketing, as shown in the earlier trial PC45a. Use of the anti-ethylene compound silver thiosulphate (STS), applied prior to marketing, was shown to reduce the degree of bud drop over a range of varieties, but there is a question mark over its future. Other non-silver anti-ethylene compounds (ethylene inhibitors) are beginning to appear in response to the need to improve vase life of cut flowers. Potential products include Chrysal EVB and Chrysal wholesale (Chrysal-Pokon, Holland) and Florish (Abbott Laboratories, Chicago, USA). These need monitoring for their potential to reduce bud drop on crops such as *Fuchsia*.

The commercial objective of the work would be to test ethylene inhibitors for improving shelf life of a range of *Fuchsia* grown with or without supplementary lighting (SON/T AGRO lamps, which were shown to be the better light source in terms of improving quality in PC45a). In addition the effects of 24 hr low temperature treatments prior to shelf life to simulate transport conditions would also be investigated.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

- Accelerated production schedules
- Improved quality of final product
- Improved shelf life, particularly during marketing
- Extrapolation of results to other 'difficult' crops, ie. New Guinea Impatiens

4. SCIENTIFIC/TECHNICAL TARGET OF WORK

To assess the potential of non-silver ethylene inhibitors in improving bud holding attributes and shelf life of a

range of *Fuchsia* varieties, particularly when using supplementary lighting as a means of improving scheduling and plant quality.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

Continues on from the earlier trial PC45a.

6. DESCRIPTION OF WORK IN YEAR 2

Provisional treatments*

Lighting Treatments:	Unlit
	Lit 2500 lux using SON/T AGRO lamps for 12-16 hours/day throughout production
Shelf life chemicals applied prior to marketing: (50% flowering date)	Untreated control STS (treated control) + 2 other non-silver ethylene inhibiting compounds.
Varieties:	Beacon Rose Winston Churchill Miss California
Additional observation:	Extra plants in untreated control subject to 24 hrs at 10°C and 5°C prior to shelf life to simulate transportation 'shock'.
Culture:	Standard PGR regime to be followed.

* It is likely that the treatment list will be modified following further discussion with the HDC, the project co-ordinator, other scientists and the manufacturers of the shelf life chemicals.

Design:

4 main plots (2 lighting x 2 replicates)
x
3 replicates within compartment

12 sub-plots
x
4 shelf life treatments within each sub-plot at marketing

48 plots/variety
x
3 varieties

144 plots in total

Assessments: Literature search on bud drop in *Fuchsia* (This will build on the HDC review of bedding plant shelf life - PC45)

Time to 50% flowering

Growth and habit of plant at marketing

Shelf life over a 3 week period following being taken to and from market by road

Photographs at all stages of production

Cost of treatments

7. COMMENCEMENT DATE AND DURATION

Year 1: Start date 01.01.92; duration 7 months.

Year 2: Start date 01.01.93; duration ~~8~~ 7 months. P.P.G.

8. STAFF RESPONSIBILITIES P.P.G.

Trials Officers: ~~Dr E Attfield~~/Mr L Sach, HRI Efford

9. LOCATION

HRI Efford

Contract No: PC/45a-ext

TERMS AND CONDITIONS

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

Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Council

Signature.....

Position.....

Date.....