Agricultural Development & Advisory Service

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CONTRACT REPORT

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Pot Chrysanthemums: Lighting for Winter Quality

Undertaken for HDC

PRINCIPAL WORKER

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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.

.... A J Dyke NDH
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Summary

Pot chrysanthemums cv 'Bright Golden Princess Anne' were grown from stickings in weeks 40, 43, 46 and 49. Supplementary lighting from SON/T lamps was given during the first two weeks of short days for 11 hours/day at 3, 5 or 7.5 k lux. Control plants were also grown without short day lighting. All pots were spaced at $25/m^2$ during the first two weeks of short days, then at $11/m^2$.

Lighting at 3 k lux significantly improved the bud count and uniformity in flowering compared with unlit plants. There was evidence that lighting at 7.5 k lux resulted in better uniformity and a higher bud count than lighting at lower levels. Uniformity in height of plants in a pot was not affected by lighting. Lighting at 3 k lux and 7.5 k lux reduced production time by over 6 and 8 days respectively compared with unlit plants during the period of the experiment.

If reductions in production time of 6 and 8 days are assumed for two weeks of short day lighting at 4 k lux and 7.5 k lux respectively over a 16 week lighting period, lighting at 4 k lux would be economic but not 7.5 k lux. If the improved quality was also considered, the 7.5 k lux treatment gave the largest difference between returns and cost.

An observation on the effects of short day supplementary lighting on seventeen Yoder Toddington cultivars was also made.

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Introduction

A major factor affecting the quality of pot chrysanthemums is the uniformity in height and flowering of the five plants in a pot. Variability is particularly a problem with disbudded Princess Anne cultivars. Work at Lee Valley EHS during the winter 86/87 and 87/88 has shown that variability increases during the mid-winter period. This suggested that light is a factor determining uniformity.

In 1987/88, continuous supplementary lighting applied at 3.5 to 4.0 k lux during the second week of long days had no effect on a succession of crops potted in weeks 40 (1987) to 8 (1988). Supplementary lighting during the first two weeks of short days for 11 hours per day at 7.5 k lux advanced flowering by up to 10 days and gave a small increase in the number of buds.

There was some indication of an interaction between short day lighting and plant density, although this was only statistically significant at a level of probability of 8.5%, not the conventional 5%. Short day lighting reduced the variability of plants spaced at $16/m^2$ in five out of six potting dates. The lighting treatment had little or no effect on plants spaced at $25/m^2$.

Natural light levels were atypical with lower than average light in October, November and December and higher than average light in February. The results obtained may therefore differ from those which would be obtained under average winter light levels.

The objectives of the 1988/89 work were as follows:

1 To re-assess the economics of supplementary lighting of pot chrysanthemums during the first two weeks of short days, in terms of reduction in production time and quality improvement, under different natural light conditions to those in the winter of 1987/88.

2 To investigate the effect of lower supplementary light levels to those used in 1987/88

Materials and Methods

Treatments

1 Supplementary lighting for the first two weeks of short days for 11 hours/day, 07.00 - 18.00 using SON/T lamps

i) Control, unlit
ii) 3.0 k lux (1.30 W/m^2)
iii) 5.0 k lux (2.17 W/m^2)
iv) 7.5 k lux (3.26 W/m^2)

2 Sticking dates:

i) Week 40
ii) " 43
iii) " 46
iv) " 49

Experimental design

Lighting treatments were applied to two replicates in two separate houses. After lighting treatments were completed, all the plants of one sticking date were grown on in the same house, with the two replicates grown on separate benches. Each plot consisted of 12 fully guarded pots.

Cultural details

Sticking:	Unrooted cuttings of chrysanthemum cv Bright Golden Princess Anne were direct stuck into 140 mm (1 litre) dwarf pots filled with a peat compost (Fisons M2). Rooting hormone was applied by the propagator
Rooting:	Pots were placed into polystyrene pot carrying trays and placed on a heated bench, set to give a compost temperature of 18 - 20^{o}C. After sticking, the cuttings were covered with thin, clear polythene. After 5 to 7 days, the sheets were removed and the plants were grown on capillary matting
Daylength:	Long days for two weeks after sticking were provided by tungsten lamps at 100 lux for 3 hours/night in October and 4 hours/night in November and December. After two weeks of long days, the plants were moved into natural short days
Pinching:	Plants were pinched when a reasonably sized tip could be removed, leaving 7 fully expanded leaves behind
Disbudding:	Side buds were removed when they were about 4 mm in diameter (approximately 3 weeks before marketing)

Pot spacing:

Week 1 long days	- pot thick	(50/m^2)
Week 2 long days	- 160 mm x 160 mm	(39/m^2)
Weeks 1 & 2 short days	- 200 mm x 200 mm	(25/m^2)
Week 3 short days to marketing	- 300 mm x 300 mm	(11/m^2)

Temperature: A heating set point of 16^{o}C was used throughout. A ventilation set point of 18^{o}C was used during weeks 1 and 2 of long days and 20^{o}C from week 1 of short days to marketing

CO_2: Enrichment using pure CO_2 during the daytime to 800 ppm when the vents were less than 5% open and to 330 ppm when the vents were 5% or more open

Nutrition: Plants were liquid fed, the levels of nutrients being varied according to sticking date and compost analysis

Growth regulants: Chlorphonium chloride (Phosphon) was incorporated into the compost at 0.4 kg/m^3. Daminozide (Alar) was applied as a foliar spray at the following stages and rates:

3 days post sticking	0.75 g/litre
7 " " "	3.0 "
14 " " "	4.5 "
21 " " "	3.0 "

Additional sprays were given to individual crops as required

Pest & disease control: details are given in Appendix I

Measurements

Pots were recorded when at least one flower in the pot had reached stage 6 (Cockshull 1972). The following measurements were recorded:

1 Date of assessment

2 Total number of flowers and buds showing colour

3 Stage of development of the most advanced flower or bud on each of the five plants in each pot, according to the 1-10 scale of Cockshull (1972)

4 The height of each plant from the stem base to the base of the tallest flower

Variance, a measure of the amount of variability, both in height and flower stage, was calculated for each pot. A higher figure indicates higher variability.

Results

Natural radiation figures at Lee Valley EHS during the winter of 1988/89 are shown in Table 1. Radiation was fairly typical of average levels and significantly higher during November, December and January than in the same months in the 1987/88 winter.

Plant growth and flowering

The production time required to obtain a marketable plant was longest from the week 46 sticking (Table 2). Two weeks of short day lighting at 7.5 k lux reduced the production time by an average of over 8 days with the greatest reduction in the crop stuck in week 46. The difference between lighting at 3 k lux and 7.5 k lux was 2 days. Short day lighting significantly increased the number of buds and flowers showing colour (Table 3). The difference between unlit plants and plants lit at 3 k lux was greater than that between plants lit at 3 k lux and plants lit at 7.5 k lux.

Plant height was not affected by the lighting treatments but there were apparent differences in plant height between crops (Table 4). Crops stuck in weeks 40 and 46 should have had less Alar and unlit plants stuck in week 49 should have had more Alar to achieve the optimum height of 150 - 175 mm.

Uniformity in Height and Flowering (Tables 5 and 6)

Uniformity improved with sticking date from week 40 to week 49. All the lighting treatments significantly improved uniformity. The difference between plants lit at 7.5 k lux and those lit at lower levels was not quite significant at P = 0.05.

Uniformity in height was better in crops potted in weeks 43 and 46 than in weeks 40 and 49 but was not affected by the lighting treatments.

Table 1: Radiation figures at Lee Valley EHS

	$MJ/m^2/day$			% difference	
	a	b	c		
	1963-1987				
Month	Average	1987/88	1988/89	c/a	c/b
October	6.30	6.33	5.88	-6.7	- 7.1
November	3.12	2.44	3.36	+7.7	+37.7
December	1.86	1.45	1.78	-4.3	+22.8
January	2.35	2.29	2.49	+6.0	+ 8.7
February	4.42	5.54	4.85	+8.9	-14.2
March	7.95	7.88	-	-	-
April	12.31	12.34	-	-	-

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Table 2: Production time of unlit plants and advance in time resulting from lighting, days

Week stuck	Unlit	Unlit	Illuminance, k lux 3	5	7.5
	Production time		Advance		
40	83	0	6.0	5.5	6.5
43	90	0	7.0	8.0	8.5
46	97	0	8.0	9.5	12.0
49	90	0	4.0	5.0	6.5
Mean	90	0	6.25	7.00	8.38

LSD (P = 0.05) between lighting treatment means = 0.79

" " between lighting treatments in any week = 1.58

Table 3: Effect of lighting on the number of buds and flowers showing colour

Week stuck	0 (Unlit)	Illuminance, k lux 3	5	7.5
40	9.0	10.5	11.0	12.0
43	10.0	10.5	10.5	11.5
46	9.5	10.5	11.0	11.5
49	9.5	12.5	12.5	13.0
Mean	9.50	11.0	11.25	12.0

LSD (P = 0.05) between lighting treatment means = 0.82

" " between lighting treatments in any week = 1.64

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Table 4: Effect of lighting on plant height, mm

Week stuck	Illuminance, k lux 0 (Unlit)	3	5	7.5
40	132	130	130	138
43	153	157	160	161
46	122	124	125	123
49	199	175	174	176
Mean	151	146	147	149

No significant lighting treatment effects at P = 0.05

Table 5: Effect of lighting on flower stage variance

Week stuck	Illuminance, k lux 0 (Unlit)	3	5	7.5
40	1.05	0.93	0.89	0.77
43	0.97	0.92	0.80	0.86
46	0.94	0.80	0.86	0.87
49	0.84	0.81	0.89	0.71
Mean	0.95	0.86	0.86	0.80

LSD (P = 0.05) between lighting treatment means = 0.07
" " between lighting treatments in any week = 0.15

Table 6: Effect of lighting on height variance

Week stuck	Illuminance, k lux			
	0 (Unlit)	3	5	7.5
40	17.3	18.7	16.9	14.0
43	11.6	13.7	12.1	11.6
46	11.3	10.2	12.0	11.7
49	19.9	16.7	15.8	12.1
Mean	14.1	14.78	15.02	12.35

No significant lighting treatment effects at P = 0.05

Discussion

The results for uniformity in flowering differ from those in the winters of 1986/87 and 1987/88. In the previous winters, uniformity in flowering of unlit plants was closely related to natural light levels with the lowest uniformity occurring in crops stuck in weeks 44 and 48. In the present winter, the lowest uniformity in flowering of unlit plants was found in the crop stuck in week 40. The uniformity in flowering of all unlit crops stuck in the winter of 1988/89 was lower than that of a crop stuck in mid September (week 37) which had a flower variance of 0.79. This confirms that natural light is a factor which determines uniformity in flowering.

In the present experiment, supplementary lighting during the first two weeks of short days significantly improved uniformity in flowering. There was evidence that the best uniformity was obtained using a light level of 7.5 k lux. In the winter of 1987/88 there was some evidence (significant at 8.5%) that lighting only improved uniformity at a spacing of 16 pots/m^2 and not at a spacing of 25 pots/m^2, which was used in the present experiment. It is possible that plants required a wider spacing in 1987/88 due to the poor natural light. However, the overall uniformity in flowering of unlit plants was similar in 1987/88 and in 1988/89.

Supplementary lighting had no effect on uniformity in height in either the present experiment or in the previous two winters.

The effects of supplementary lighting on production time were greater than those found in the previous winter. The present results indicate that the average saving in production time for a complete lighting season (week 40 to week 8) resulting from 2 weeks of short day lighting at 7.5 k lux would be about 8 days per crop . Canham (1972) found that the reduction in production time of cv Bright Golden Princess Anne resulting from two weeks of short day lighting was in direct proportion to the irradiance in the range 11.6 to 28.9 W/m^2 (5.0 to 12.6 k lux equivalent for SON/T). The present results show that 75% of the reduction in production time achieved using a light level of 7.5 k lux can be obtained using a light level of between 3 and 5 k lux.

Economics of lighting

Since the experiment was only conducted over a 9 week lighting period, for the purposes of economic calculations, assumptions on the likely response over a 16 week lighting period have been made.

The economics of lighting for the first two weeks of short days at 4 k lux (taken as the average of the 3 k lux and 5 k lux treatments) and 7.5 k lux, assuming reductions in production time of 6 and 8 days respectively, are shown in Appendix II. The results show that in terms of reduced production time alone, lighting at 4 k lux would be economic whereas the cost of lighting at 7.5 k lux would not be fully recovered. However, the costing assumed that all the pots were of similar quality; the quality differences which were found in the present experiment were not included.

Table 7 shows the average gross prices and margins obtained by a commercial grower during the winter of 1988/89. The uniformity of flowering, expressed as a variance in flower stage development, necessary for each grade is shown.

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Table 7: Average gross prices, margins and flower uniformity for grades of pot chrysanthemum

Grade	Gross price	Margin	Flower uniformity
Supermarket	£1.49	£0.71	0.75
Grade I wholesale	£1.23	£0.45	0.95
Grade II "	£0.98	£0.20	1.15
Unmarketable	0	-	1.35

Margin in Table 7 refers to the gross price minus marketing costs (commission, handling, packing and carriage) and production costs excluding heating (these costs have been calculated at 78 p/pot).

Assuming uniformity in flowering is the major factor affecting quality, the estimated average margins and returns for different lighting treatments for a 16 week period would be as shown in Table 8.

Table 8: Economics of lighting treatments, including the effects on pot quality

Illuminance k lux	Estimated Average margin, £/pot	Production pots/acre/ week	Returns/ acre/ 16 weeks	Returns - Lighting cost/ acre*
Unlit	0.50	4888	£39,104	£39,104
4	0.61	5385	£52,558	£49,586
7.5	0.67	5539	£59,378	£54,078

* The lighting costs (Appendix II) for 16 weeks were £5300/acre at 7.5 k lux and £2972/acre at 4 k lux

The production levels in Table 8 have been calculated assuming reductions in production time of 6 and 8 days for 4 k lux and 7.5 k lux respectively.

The table shows that if pot quality, in terms of uniformity of flowering, is considered, the relative economics of the 4 k lux and 7.5 k lux treatments is reversed, compared with the costing in Appendix II which only considered production levels. Table 8 shows that for lighting at 7.5 k lux to be economic, the effects on pot quality must also be considered.

Conclusions

Effects of two weeks of short day supplementary lighting

1 Lighting at 3 k lux or greater significantly improved uniformity in flowering compared with unlit plants. There was evidence that lighting at 7.5 k lux resulted in better uniformity than lighting at lower levels

2 Uniformity in height of plants in a pot was not affected by lighting

3 The number of buds and flowers showing colour was significantly increased by lighting. Lighting at 7.5 k lux resulted in a higher bud count than lighting at 3 k lux

4 Production time was reduced by an average of over 8 days by lighting at 7.5 k lux in crops stuck between weeks 40 and 49. Lighting at 3 k lux reduced production time by over 6 days compared with unlit plants

5 If reductions in production time of 6 and 8 days are assumed for two weeks of short day lighting at 4 k lux and 7.5 k lux respectively, lighting at 4 k lux would be economic but not at 7.5 k lux (based on a 16 week lighting period)

6 When the effects of the lighting treatments on both reduced production time and improved quality, in terms of better uniformity in flowering, were considered, short day lighting at 7.5 k lux gave the largest difference between returns and cost

Recommendations for further work

1 The effect of short day lighting at different plant densities on the uniformity in flowering should be examined in a further season

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There is evidence that the effectiveness of short day lighting in reducing variability is influenced by plant density and by the natural light level

2 Suggested treatments for a further experiment are:

Short day lighting:	7.5 k lux, 4 k lux, unlit
Plant densities during lighting (pots/m^2):	16, 20, 25
Potting dates:	Weeks 40 - 8

References

Canham, A.E. (1972) Supplementary artificial light for pot chrysanthemums: a cultivar response trial and comparison of light sources. Electricity Council Research Report ECR/R514

Cockshull, K.E. and Hughes, A.P. (1972) Flower formation in *Chrysanthemum morifoleum*: the influence of light and temperature. *J. Hort. Sci.* *47*, 113-127

Ellis, S.R. (1988) Pot chrysanthemums, lighting for winter quality. Lee Valley EHS Contract Report C87/0360

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APPENDIX I

Disease control

Botrytis:	Chlorothalonil (as Repulse at 2.2 ml/litre) immediately after sticking
White rust prevention:	Triforine (as Saprol at 0.75 ml/litre) immediately after sticking

Pest control

Two spotted spider mite:	Fenbutatin oxide (as Torque at 0.5 g/litre)
	Dienochlor (as Pentac at 0.65 ml/litre)
Aphids:	Diazinon at 1 ml/litre Heptenophos (as Hostaquick at 0.75 ml/litre)
Whitefly	Cypermethrin (as Ambush at 0.5 ml/litre)
	Gamma HCH (as Lindane at 0.6 ml/litre)

APPENDIX II

ECONOMICS OF SUPPLEMENTARY LIGHTING

Based on throughput, no quality improvements assumed
A margin of 50/pot (gross price minus marketing costs and production costs excluding heating) is assumed

Capital Costs Assumed

400 W SON/T lamp installed: £160
Amortised over 5 years, interest charged at 13%
Lamp in use for 16 weeks

Running Costs Assumed

Electricity cost: 5.7p/kWh standard rate
15% of electricity costs recovered as 'free heat'
Lighting for 11 hours/day for the first two weeks of short days of each crop. Loading/lamp - 440 W
Crops grown at 25 pots/m^2 during 2 weeks lit

a) Lighting at 7.5 k lux, assuming cropping period reduced by 8 days

Capital cost
Lit area = 6 m^2 per lamp
Capital costs = £0.95/m^2 bench for 2 weeks = 3.8p/pot

Running costs

$$\frac{0.44 \text{ KW} \times 11 \text{ hours} \times 14 \text{ days} \times 5.7\text{p/kWh}}{6 \text{ m}^2} = £0.64/\text{m}^2 \text{ bench}$$

= 2.56/pot - 15% = 2.18/pot
Capital + Running costs = 5.86/pot

Benefits from lighting

Unlit winter production	= 4888 pots per acre per week
Winter production with two weeks of lighting at 7.5 k lux	= 5539 pots per acre per week
Extra throughput with lighting is 5539-4888	= 651 pots per acre per week

Over 16 weeks	= 10416 pots per acre
Revenue on 10416 pots @ 50p/pot	= £5208 per acre
Cost of lighting 16 x 5539 pots	= £5300 per acre
Revenue-Cost	= £92/acre loss

b) Lighting at 4 k lux, assuming cropping reduced by 6 days

Capital cost

Lit area = 10.25m² per lamp

Capital cost = £0.55/m² bench for 2 weeks = 2.22p/pot

Running cost

$$\frac{0.44 \text{ kW} \times 11 \text{ hours} \times 14 \text{ days} \times 5.7 \text{ p/kWh}}{10.25}$$

= 1.5p/pot - 15% = 1.28p/pot

Capital + Running Cost = 3.5p/pot

Benefits from lighting

Unlit winter production	= 4888 pots per acre per week
Winter production with two weeks of lighting at 4 k lux	= 5385 pots per acre per week
Extra throughput with lighting is 5385-4888	= 497 pots per acre per week
Over 16 weeks	= 7952 pots per acre
Revenue on 7952 pots @ 50p/pot	= 3976 per acre
Cost of lighting 16 x 5385 pots	= 3016 per acre
Revenue-cost	= £960 per acre

EFFECT OF SUPPLEMENTARY LIGHTING ON YODER TODDINGTON CULTIVARS

The effect of lighting during the first two and four weeks of short days on 17 Yoder Toddington cultivars was examined. The observation was conducted in the outer guard areas of the main lighting trial; treatments were not replicated.

Lighting treatments:

i) Control, unlit

ii) 3 k lux, 11 hours/day 0700 - 1800 SON/T for the first two weeks of short days.

iii) as ii) for the first four weeks of short days

Cultivars:

Eleven double and six single cultivars (see Table AI).
Eight plants of each cultivar were grown under each treatment. Three typical plants were used for assessment.

Cultural details

Culture was similar as described for cv Princess Anne with the following exceptions:

Sticking date: Week 45

Daylength: Long days were given for 3 weeks after sticking.

Growth regulants: No Phosphon was added to the compost.
Daminozide (Alar) was applied at the following stages and rates:

3 days post sticking	0.75 g/litre
42 " " "	1.5 "
50 " " "	1.5 "

All plants were grown as sprays and were not disbudded.

Measurements

1. Date marketable, when the pot had at least 12 fully open flowers.

2. Total number of buds and flowers showing colour.

Shelf Life Assessment

Three unlit plants and three plants which received 4 weeks of supplementary lighting of each cultivar were placed in a product life room when they had reached the marketable stage. The product life room was kept at 18°C and lit with a combination of daylight and fluorescent lamps (07.00 - 18.00). Pots were watered with plain water from the tap. After 14 and 21 days, the number of wilted flowers or flowers with brown petals or centres were recorded.

Results and Discussion

The following results are indications only since treatments were unreplicated.

Date marketable (Table AI)

Single cultivars were marketable, on average, three days earlier than double cultivars. Lighting for the first two weeks of short days at 3 k lux reduced production time by an average of 4 days compared with unlit plants. Lighting for the first 4 weeks of short days reduced production time by one week.

Number of buds and flowers (Table AII)

The lighting treatments generally had little or no effect on the number of buds and flowers.

Shelf Life (Table AIII)

There were large differences in shelf life between the cultivars. The double cultivars generally had a better shelf life than the single cultivars, which tended to turn brown in the centre. Of the single cultivars, Rainet and Yellow Ovaro had the best shelf life; Pico and Spears were the worst cultivars. Of the double cultivars, Charm, En Garde, Iridon, and Yellow Favor had worse shelf lives than the rest.

With the exception of the cultivar Tan, lighting tended to improve or had no effect on shelf life, depending on the cultivar.

TABLE AI Date marketable, 1= day 64 from sticking

Single cultivars	Lit 4 weeks 3 k lux	Lit 2 weeks 3 k lux	Unlit
Tan	1	3	8
Pico	3	8	13
Spears	5	6	6
Pert	6	8	17
Yellow Ovaro	6	8	13
Rainet	14	20	22
Mean	6	9	13

Double cultivars	Lit 4 weeks 3 k lux	Lit 2 weeks 3 k lux	Unlit
Surf	3	8	13
Envy	6	8	15
Salmon Charm	6	6	10
Surfine	6	10	15
Charm	8	8	15
Quest	8	10	13
Pomona	12	14	16
En Garde	13	17	20
Yellow Favor	13	13	15
Tempter	14	14	17
Iridon	17	24	29
Mean	10	12	16

TABLE AII Number of buds and flowers showing colour at marketing

Single cultivars	Lit 4 weeks 3 k lux	Lit 2 weeks 3 k lux	Unlit
Tan	44	32	34
Pico	29	24	25
Spears	24	25	28
Pert	31	25	34
Yellow Ovaro	30	26	30
Rainet	37	34	41
Mean	33	28	32

Double cultivars	Lit 4 weeks 3 k lux	Lit 2 weeks 3 k lux	Unlit
Surf	35	29	22
Envy	21	21	20
Salmon Charm	26	25	24
Surfine	38	28	27
Charm	20	21	20
Quest	20	19	19
Pomona	42	34	34
En Garde	26	21	26
Yellow Favor	36	29	31
Tempter	24	27	27
Iridon	30	30	36
Mean	29	26	26

TABLE AIII Number of brown or wilted flowers and percentage of total flowers (in brackets)

Single Cultivars	Day 14				Day 21			
	Lit 4 wks		Unlit		Lit 4 wks		Unlit	
Pico	24	(83)	25	(100)	25	(100)	25	(100)
Pert	8	(26)	8	(24)	13	(42)	32	(94)
Rainet	1	(3)	4	(9)	9	(24)	14	(34)
Spears	16	(67)	26	(93)	24	(100)	28	(100)
Tan	11	(25)	2	(6)	21	(48)	8	(24)
Yellow Ovaro	0	(0)	3	(10)	4	(13)	11	(36)
Mean	10	(34)	11	(40)	16	(54)	20	(66)

Double Cultivars								
Charm	0	(0)	0	(0)	6	(30)	6	(30)
En Garde	1	(4)	0	(0)	1	(4)	20	(76)
Envy	1	(3)	1	(3)	2	(6)	2	(6)
Iridon	2	(7)	5	(15)	8	(28)	15	(45)
Quest	0	(0)	0	(0)	2	(8)	4	(16)
Salmon Charm	2	(8)	5	(20)	1	(4)	6	(24)
Surf	0	(0)	0	(0)	0	(0)	0	(0)
Surfine	0	(0)	0	(0)	1	(3)	1	(5)
Yellow Favor	0	(0)	9	(29)	7	(21)	31	(100)
Mean	1	(2)	2	(7)	3	(12)	9	(35)

Conclusion (tentative) and Recommendation for Further Work

Short day lighting appears to give worthwhile reductions in the production times of Yoder Toddington cultivars. The use of higher light levels, as were used for cv Princess Anne, during the first two weeks of short days should be investigated.