Project title:	Poinsettia – Energy saving trial, costing and quality
Project number:	PO 001
Project leaders:	Dirk Ludolph LVG Ahlem Heisterbergallee 12 D-30453 Hannover Harry Kitchener H K Consulting 2 High Piece Crescent Over Cambridgeshire CB24 5NR
Report:	Final report, January 2011
Key staff:	Dirk Ludolph Harry Kitchener
Location of project:	LVG Ahlem
Industry Representative:	H M Kitchener
Date project commenced:	3rd August 2009
Date project completed (or expected completion date):	31st December 2009

DISCLAIMER:

AUTHENTICATION

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

[Name]
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GROWER SUMMARY

Headline

Reducing heat set points during short days resulted in a calculated oil saving of up to 4 l/m^2 (or £2.00/m^2 at an oil cost of 50p/l). As would be expected, production at lower temperature delayed marketing and reduced plant size / quality and, of the varieties tested, those impacted least by lower temperature production included 'Freedom Early', 'Monreale Early Red', 'Prestige Early Red', 'Early Milennium', 'Christmas Carol' and 'Christmas Eve'.

Background

Poinsettias are a crop grown in the UK mainly for marketing from wk 46 onwards. The fuel costs for this crop rise quickly as natural temperatures decrease and humidity increases towards the end of the year. With rising energy costs for production and no increase in price for poinsettias in real terms for the last 10 years, it is essential that heat inputs in production are minimized. Previous work, (e.g. HDC project PC 71d) has demonstrated the impacts of reducing temperature set points during the later stages of poinsettia production when there is less solar gain and more heat required from the glasshouse heating system. As a result it is recognized that lowering production temperatures will reduce plant size, although this may be compensated for though earlier potting. Lower temperature will also delay bract reddening and cyathia development and high humidity may cause quality defects and increase incidence of disease. Breeding efforts in recent years have aimed to reduce response times which may help with these issues and hence it was important to update the investigations into lower temperature production by evaluating newer varieties suited to production in Northern Europe in order to inform growers about the trade-off between fuel saving, time of flowering, final plant quality and hence crop marketability.

Summary

A range of 27 varieties were grown in the experimental glasshouse of LVG Ahlem which were selected to represent a range of breeders and response types.

All plants were grown in the same temperature regimes during long days with treatments commencing at the start of short days when plants were grown in either standard or cool regimes as detailed below, where HT = heat set point, VT = vent set point.

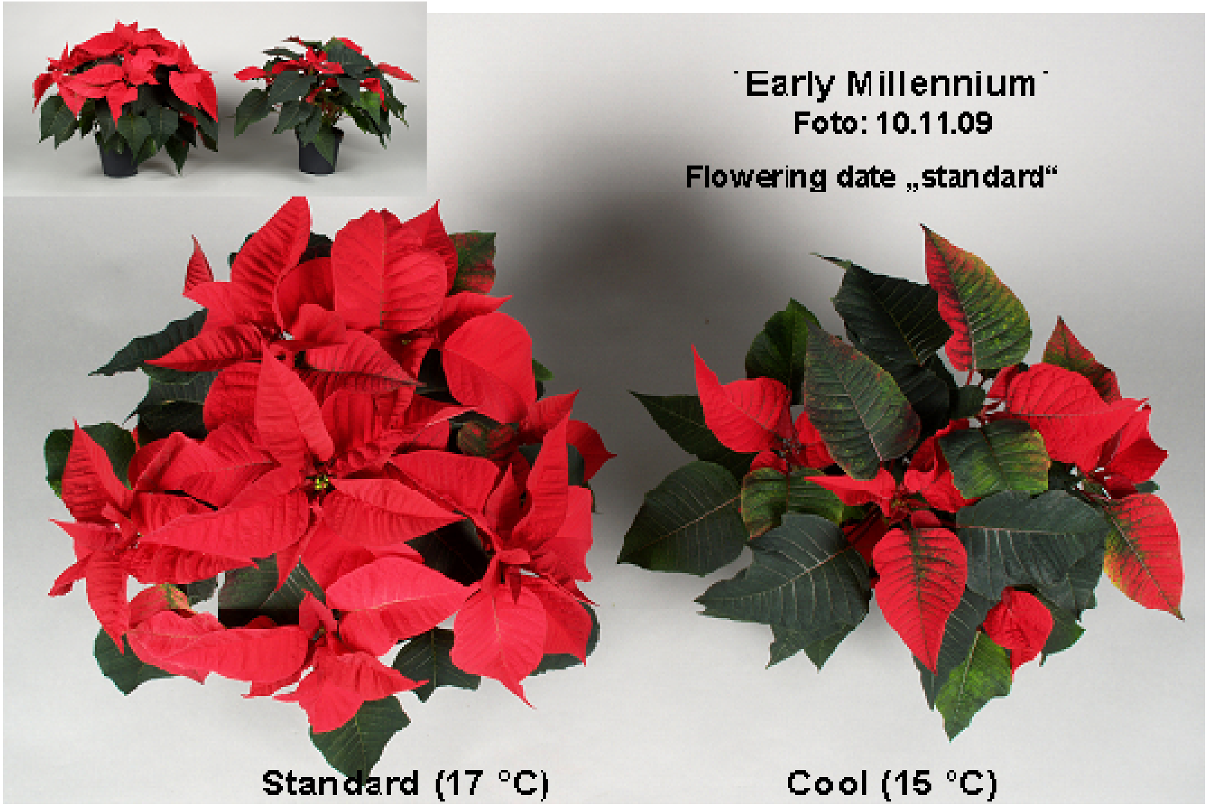
	Standard	**CoolCrop**
Potting	Week 29	Week 29
Temperature (°C) **LD** … KW 29 – 33	HT 20 VT 22	HT 20 VT 22
… KW 34 - 38	HT **16** VT 20	HT **16** VT 20
daylength	natural	natural
Temperature (°C) **SD** from week 39	HT **18 / 16** VT 20 / 20	HT **15 / 13** VT 17 / 17

When grown under standard temperatures, the response times of the varieties tested were within the range expected from breeder recommendations. Growing these varieties within the 'cool' regime however delayed response time by 4 to 21 days, depending on cultivar, with some cultivars remaining unmarketable by the second week of December as detailed in the table below. Whilst the number of days of delay resulting from production in the cool regime was higher for the earlier response varieties (at 15 to 21 days) than the later response types (at 4 to 15 days), all cool grown varieties that failed to mature in time for the marketing window were from response groups of 7.5 weeks or greater.

Influence of temperature regime on flowering date and consequent delay in marketing.

	Flowering Date		
Breeder, ***Variety,*** *Response time (weeks)*	***Standard crop***	***Cool crop***	***Delay in Market Quality (days)***
PLA Eckespoint **'Freedom Early'** (6.5)	09.11.	25.11.	16
PLA **'Early Millennium'** (6.5)	09.11.	25.11.	16
Sygenta **'Mira Red'**(6.5)	11.11.	25.11	14
FLO2 **'Alreddy Red'** (6.5)	16.11.	01.12.	15
PLA Eckespoint **'Autumn Red'** (6.5/7.0)	09.11.	27.11.	18
Red Fox **'Premium Early'** (7.0)	04.11.	25.11.	21
PLA Eckespoint **'Monreale Early'** (7.0)	13.11.	01.12.	18
Lazzeri **'Flamma'**(7.0)	13.11.	27.11.	14
sel **'Christmas Carol'**(7.0)	16.11.	01.12.	15
Red Fox **'Premium Red'** (7.0)	17.11.	05.12.	21
PLA Eckespoint **'Prestige Early'** (7/7.5)	13.11.	27.11.	14
FLO2 **'Stargazer Red'** (7.0/8.0)	23.11.	05.12.	15
Lazzeri **'Allegra'**(7.5)	23.11.	01.12.	8
PLA **'Mars Improved'** (7.5)	23.11.	01.12.	8
sel **'Christmas Day'**(7.5)	25.11.	29.11.	4
Red Fox **'Early Glory'** (7.5)	25.11.	05.12.	10
Red Fox **'Infinity Red'** (7.5)	25.11.	…	No market quality
Red Fox **'Infinity Bright Red'** (7.5)	25.11.	…	No market quality
sel **'Happy Christmas evol.'**(7.5)	25.11.	07.12.	12
sel **'Noel'**(7.5)	25.11.	07.12.	12
PLA Eckespoint **'Cortez Electric Fire'** (7.5/8.0)	20.11.	…	No market quality
Red Fox **'Champion Red'** (7.5/8.5)	25.11.	10.12.	15
Red Fox **'Viking'** (8.0)	20.11.	01.12.	11
sel **'Christmas Beauty'**(8.0)	25.11.	29.11.	4
Red Fox **'Cosmo'**(8.5)	25.11.	05.12.	No market quality
sel **'Christmas Eve evol.'**	13.11.	25.11.	12
sel **'Christmas Angel'** (not available in EU)	25.11.	…	No market quality

In general, the cool regime reduced overall plant size and hence quality as illustrated in below for ‘Early Millennium’.



Of the varieties tested, those considered to perform best in the cool regimes conditions (i.e. suffering the least in terms of reduction in quality) were:

‘Freedom Early’	‘Monreale Early Red’	‘Prestige Early Red’
‘Early Millennium’,	‘Christmas Carol’	‘Christmas Eve’

In addition to the negative impact on quality, any delay in harvesting may also mean increased fuel costs due to the increase in time the crop is on the bench. Whilst not measured here, the potential for increased incidence of disease must also be considered when growing at lower temperature and measures to reduce humidity such as increasing pipe heat or use of fans for air movement will increase energy use and risk mitigating the savings achieved by reducing set point temperatures.

Financial Benefits

If a ‘tolerant’ poinsettia variety is selected and grown then a cool grown crop may save 35 sec oil at up to 4 l/m^2 at 50p per l, equivalent to £2.00 m^2 (less any custom and excise duty).

However, the savings will be lost if quality is impaired i.e. 2 or more plants with 3 instead of 4 stars /m^2. If quality is affected then the loss may be £2.00 m^2 plus.

Delays to harvest may also increase the costs of energy, labour and other inputs to grow the crop and following crops may be delayed.

Action Points

- When considering cool growing, growers must be aware of quality specifications and selling dates to customers and select appropriate cultivars (i.e. those with short to mid range response groups i.e. 6.5 to 7.0 weeks).

- When cool growing, particular attention needs to be paid to control of humidity e.g. via air movement in order to minimize loss of quality and also incidence of disease which could result in a need for increased control for fungal disease such as *Botrytis*.

SCIENCE SECTION

Introduction

Poinsettias are a crop grown in the UK mainly for harvesting wk 46 onwards. The fuel costs for this crop rise quickly as natural temperatures decrease and humidity increases towards the end of the year. With rising energy costs for production and no increase in price for poinsettias in real terms for the last 10 years, it is essential that heat inputs in production are minimized. Previous work, e.g. PC 71 (??check number) has demonstrated the impacts of reducing temperature set points during the later stages of poinsettia production when there is less solar gain and more heat required from the glasshouse heating system. As a result it is recognized that lowering production temperatures will reduce plant size, although this may be compensated for through earlier potting. Lower temperature will also delay bract reddening and cyathia development which is a particular issue for plants with such a specific marketing window, and high humidity may cause quality defects and increase incidence of disease. Breeding efforts in recent years have aimed to reduce response times which may help with these issues and hence it is important to update the investigations into lower temperature production by evaluating newer varieties suited to production in Northern Europe in order to inform growers about the tradeoff between fuel saving, time of flowering and final quality and hence crop marketability.

Materials and methods

A range of 27 varieties, selected to represent a range of breeders and response types, were potted in week 29 and grown according to standard commercial practice in the experimental glasshouse of LVG Ahlem. Varieties were chosen to represent a range of breeders and response types.

All plants were grown in the same temperature regimes during long days with treatments commencing at the start of short days when plants were grown in either standard or cool regimes as detailed below, where HT = heat set point (^{0}C), VT = vent set point (^{0}C).

	Standard	CoolCrop
Potting	Week 29	Week 29
Temperature (°C) LD … KW 29 – 33	HT 20 VT 22	HT 20 VT 22
… KW 34 - 38	HT 16 VT 20	HT 16 VT 20
daylength	natural	natural
Temperature (°C) SD from week 39	HT 18 / 16 VT 20 / 20	HT 15 / 13 VT 17 / 17

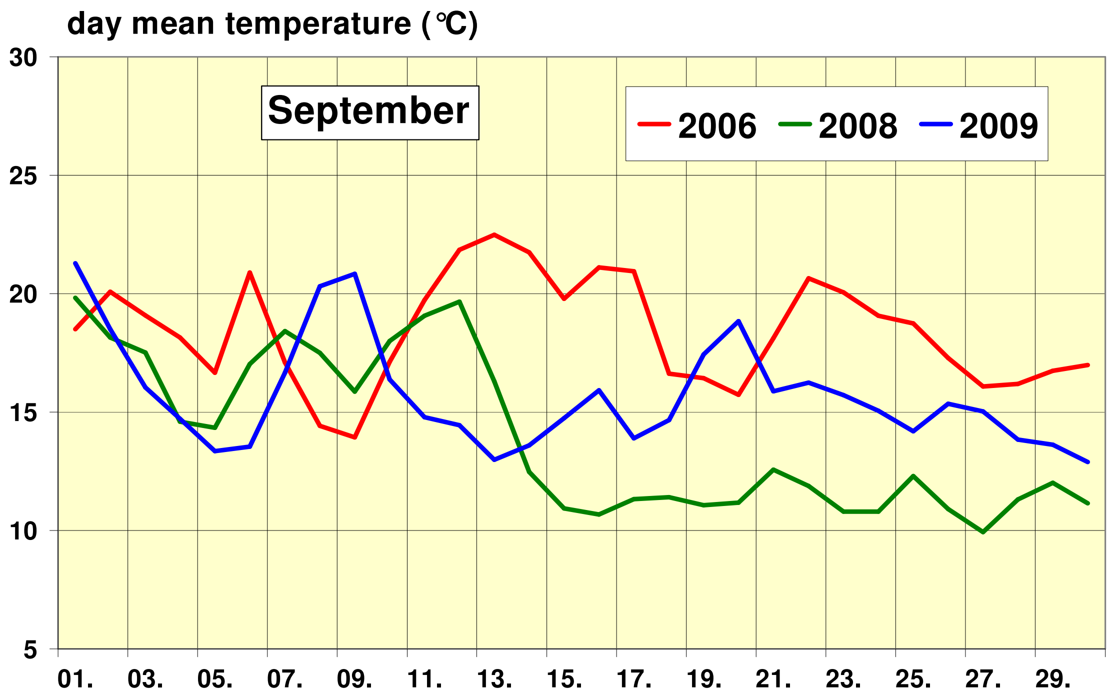
Crop growth was monitored using graphical tracking (i.e. of plant height) and final quality was assessed according to plant height and spread as well as number and size of bract stars produced. Treatments were considered to be unsuitable where plants were not ready for marketing before 10/12/09.

Results

Environmental Data

Ambient temperature – Hannover (outside)

Ambient external temperature data for the 2009 season for poinsettia production are summarised in figure 1 as mean day temperature in order to provide UK growers with an indication of how their local conditions compare with those at the trial site in Hannover. Achieved day time temperature dropped from around 21°C in the first week after potting down to a low of around 14°C 5-6 weeks after potting. A brief recovery in outside temperatures 8-10 weeks from potting was followed by a prolonged period of external temperatures of around 14-15°C for the remainder of the production period other than a slight increase between 19 and 22 weeks from potting. By comparison with mean temperature data from 2006 to 2009 it can be seen that 2009 was generally average for achieved temperature and results from the trials may be considered as representative in that they were not apparently influenced by atypical external environmental conditions.



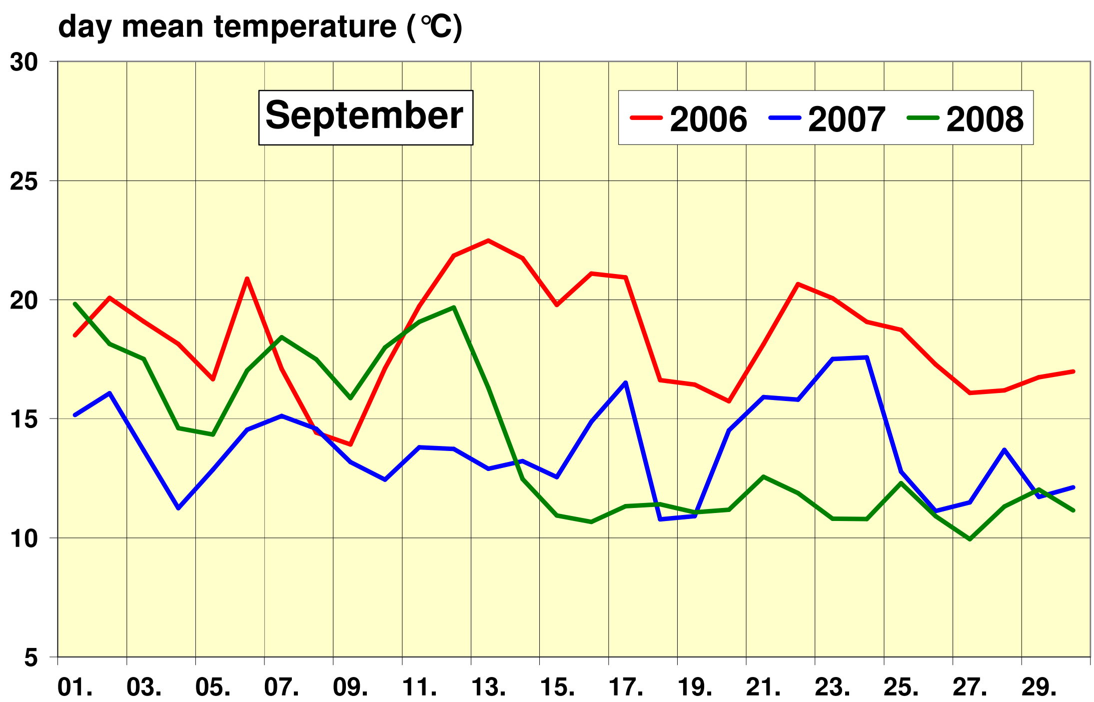


Figure 1. Achieved day time mean temperature for the poinsettia season from 2006 to 2009 at LVG Ahlem

Achieved greenhouse temperatures (°C)

Achieved average temperature compared well during long days, when both treatments were set to the same set points. Once growing with lower set points for heating and venting, there was greater difference between the two regimes during the latter part of SD (i.e. the four weeks prior to marketing) than the earlier part of SD, as would be expected given the natural decline in external temperatures as the season progresses.

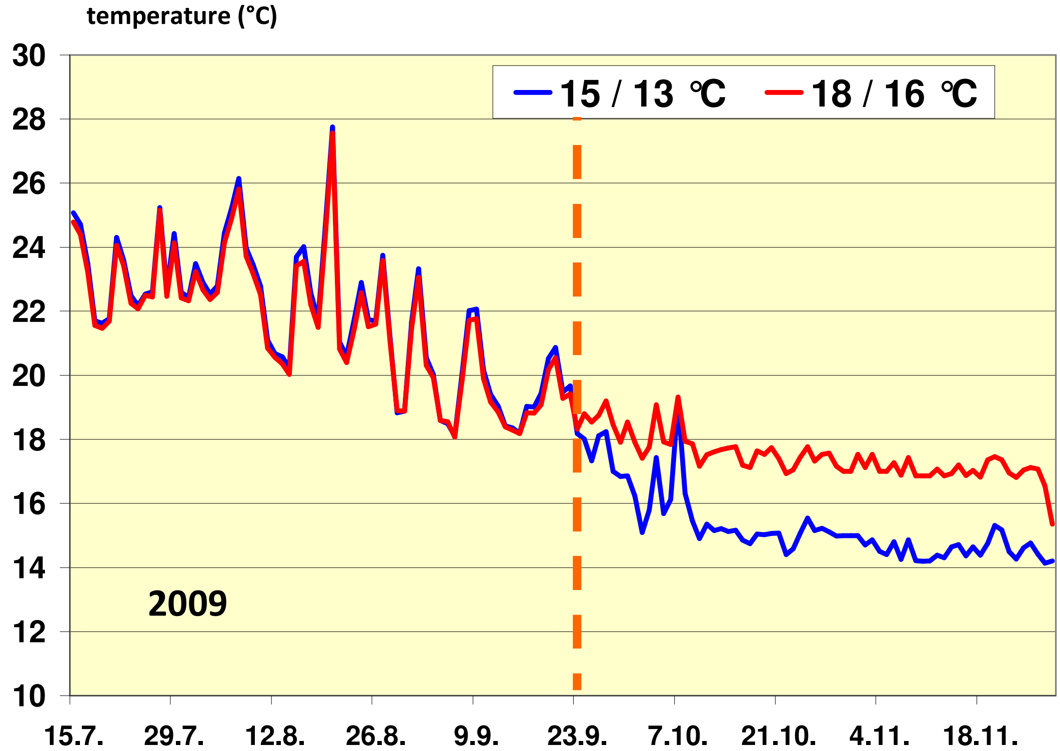
Whilst vent set point was lowered with heat set point in order to maximise treatment differences in these trials, in practise growers would be expected to lower heat set point whilst maximising solar gain through maintaining vent set point closer to that of the standard treatment, using vent and pipe heat to control humidity which would have the effect of increasing achieved temperature for the cool regime above that indicated here (table 1). Hence it can be assumed that the trials reported here represent worst case scenario for the set points tested.

Table 1. Average achieved temperature in the standard and cool treatments broken down into the LD and initial and later SD periods of growth. The figures in red indicate achieved average temperature for the whole SD period.

	Standard		CoolCrop	
Period	Week 29		Week 29	
Longday	21,6		21,8	
SD week 1 – 3	18,1	17,8	16,5	15,7
SD week 4 – 8	17,2		14,7	
Total	19,8		18,9	

Looking at achieved temperatures in more detail (figure 2), highlights how the differences between the standard and cool temperature regimes increased as the season progressed, hence the impact of the lower temperatures can be expected to have been greatest during the latter stages of growth as bracts were beginning to expand and leaves were developing colour and whilst cyathia were developing.

2(b)



2(a)

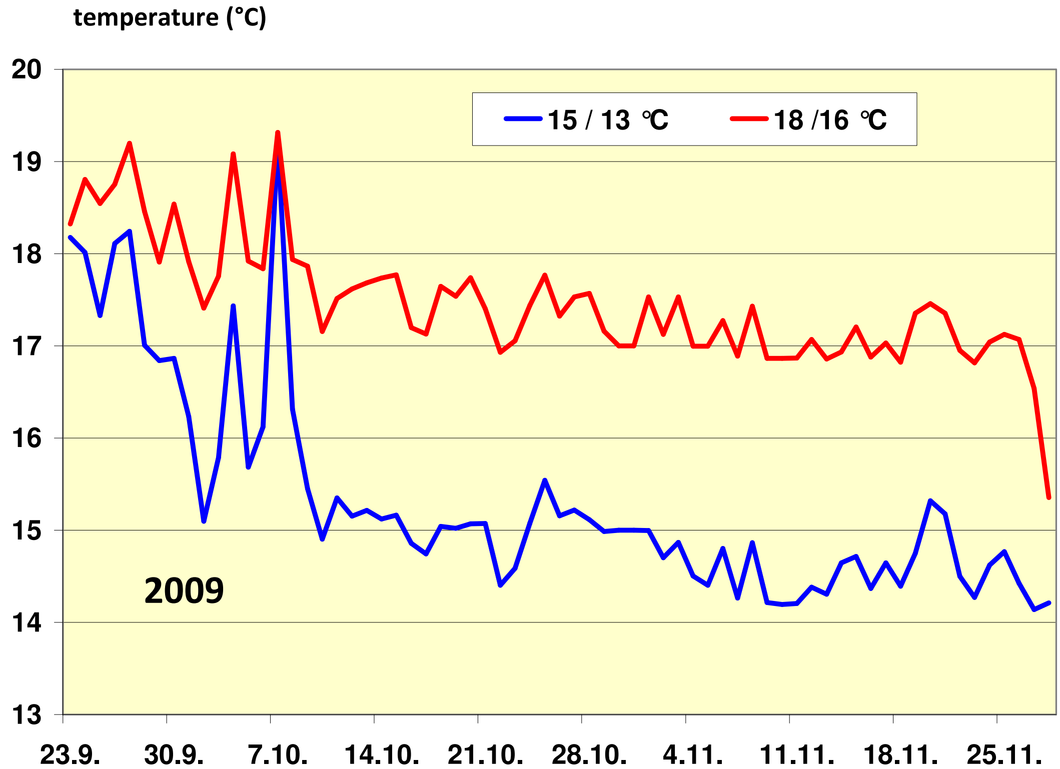
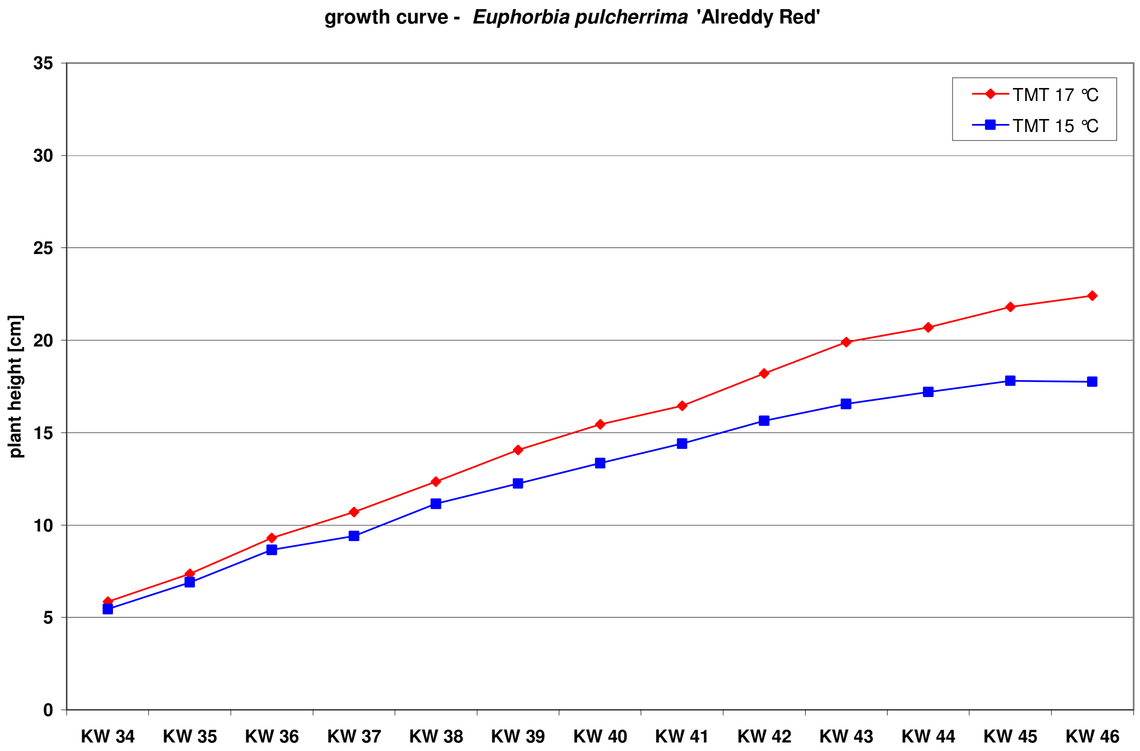


Figure 2. Achieved daily temperatures in the standard and cool treatments for the whole season **(a)** and in more detail for the short day period **(b)**.

Crop development

Plant height tracking demonstrated that varieties can be expected to respond differently to temperature regime and adjustments to crop management will need to take these data into account for growers trialling these varieties in production. For example height of Alreddy Red grown in the cool regime tracked that of the standard regime during the SD period (figure 3) whereas for Christmas Carol cool growing had little impact on plant height until week 41 when development in the cool regime notably halted compared with development in the standard regime. Hence for Alreddy Red it would be clear from week 37 / 38, that the crop is not achieving desired height and corrections in growth regulators may be applied but for Christmas Carol it may be acceptable to allow the cool grown crop to stretch above the expected progress in plant height in the initial stages of short days in anticipation of a more pronounced slow down later on. Plant height data during production for other varieties tested is given in Appendix 1.



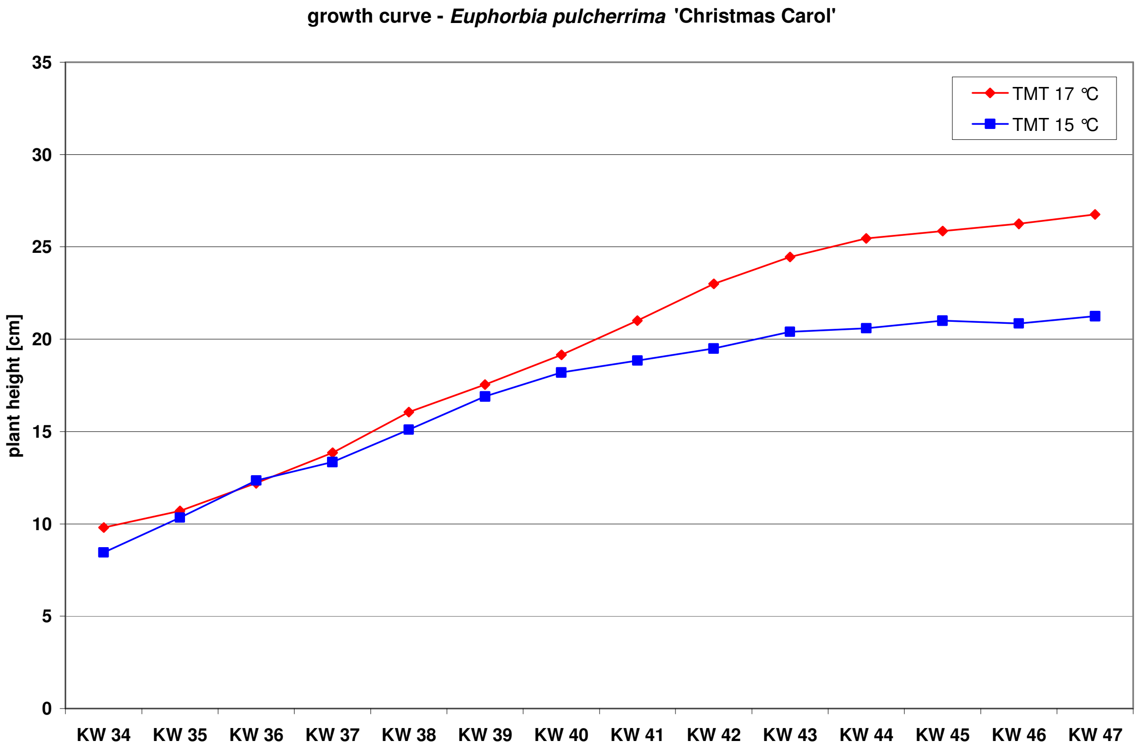


Figure 3. Growth tracking data for Alreddy Red and Christmas Carol.

Market Quality/Flowering Data

Plants grown in the standard temperature regime were ready for marketing from 04.11.09 at the earliest and 25.11.09 at the latest with marketing date generally conforming to the declared response time (table 2) and fitting in well with the window for marketing.

There was a delay in marketing date of all varieties grown in the cool temperature regime which varied between 4 and 21 days for those varieties achieving marketable quality before 12.12.09. Five of the varieties tested, Cortez Electric Fire, Cosmo, Infinity Red, Infinity Bright Red and Christmas Angel, failed to achieve marketable quality before 12.12.09 and therefore effectively missed the window for sales. All of the shorter response group varieties (i.e. 6.5 and 7 weeks) achieved marketable quality before 12.12.09. Interestingly, varieties with shorter declared response times (i.e. 6.5 to 7.0 weeks) generally had the longest number of days delay in marketing (i.e. 14 to 21 days) when grown in the cool regime. By contrast, the cool regime delayed varieties with longer response times (7.5 to 8 weeks) by 4 to 15 days. Whilst these delays are shorter they generally also made the difference as to whether or not a variety was ready for the Christmas market and hence remained detrimental for five of the longer response group varieties tested.

Table 2. Influence of temperature regime on flowering date and consequent delay in marketing.

	Flowering Date		
Breeder, ***Variety,*** *Response time (weeks)*	***Standard crop***	***Cool crop***	***Delay in Market Quality (days)***
PLA Eckespoint **'Freedom Early'** (6.5)	09.11.	25.11.	16
PLA **'Early Millennium'** (6.5)	09.11.	25.11.	16
Sygenta **'Mira Red'**(6.5)	11.11.	25.11	14
FLO2 **'Alreddy Red'** (6.5)	16.11.	01.12.	15
PLA Eckespoint **'Autumn Red'** (6.5/7.0)	09.11.	27.11.	18
Red Fox **'Premium Early'** (7.0)	04.11.	25.11.	21
PLA Eckespoint **'Monreale Early'** (7.0)	13.11.	01.12.	18
Lazzeri **'Flamma'**(7.0)	13.11.	27.11.	14
sel **'Christmas Carol'**(7.0)	16.11.	01.12.	15
Red Fox **'Premium Red'** (7.0)	17.11.	05.12.	21
PLA Eckespoint **'Prestige Early'** (7/7.5)	13.11.	27.11.	14
FLO2 **'Stargazer Red'** (7.0/8.0)	23.11.	05.12.	15
Lazzeri **'Allegra'**(7.5)	23.11.	01.12.	8
PLA **'Mars Improved'** (7.5)	23.11.	01.12.	8
sel **'Christmas Day'**(7.5)	25.11.	29.11.	4
Red Fox **'Early Glory'** (7.5)	25.11.	05.12.	10
Red Fox **'Infinity Red'** (7.5)	25.11.	…	No market quality
Red Fox **'Infinity Bright Red'** (7.5)	25.11.	…	No market quality
sel **'Happy Christmas evol.'**(7.5)	25.11.	07.12.	12
sel **'Noel'**(7.5)	25.11.	07.12.	12
PLA Eckespoint **'Cortez Electric Fire'** (7.5/8.0)	20.11.	…	No market quality
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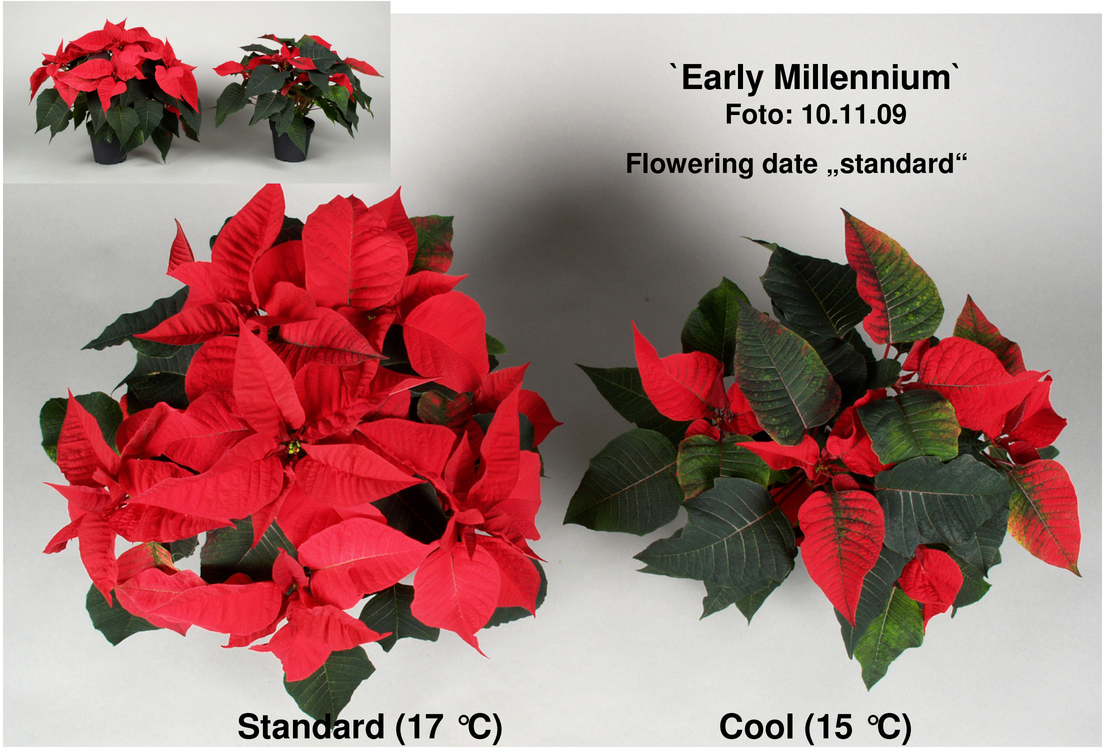
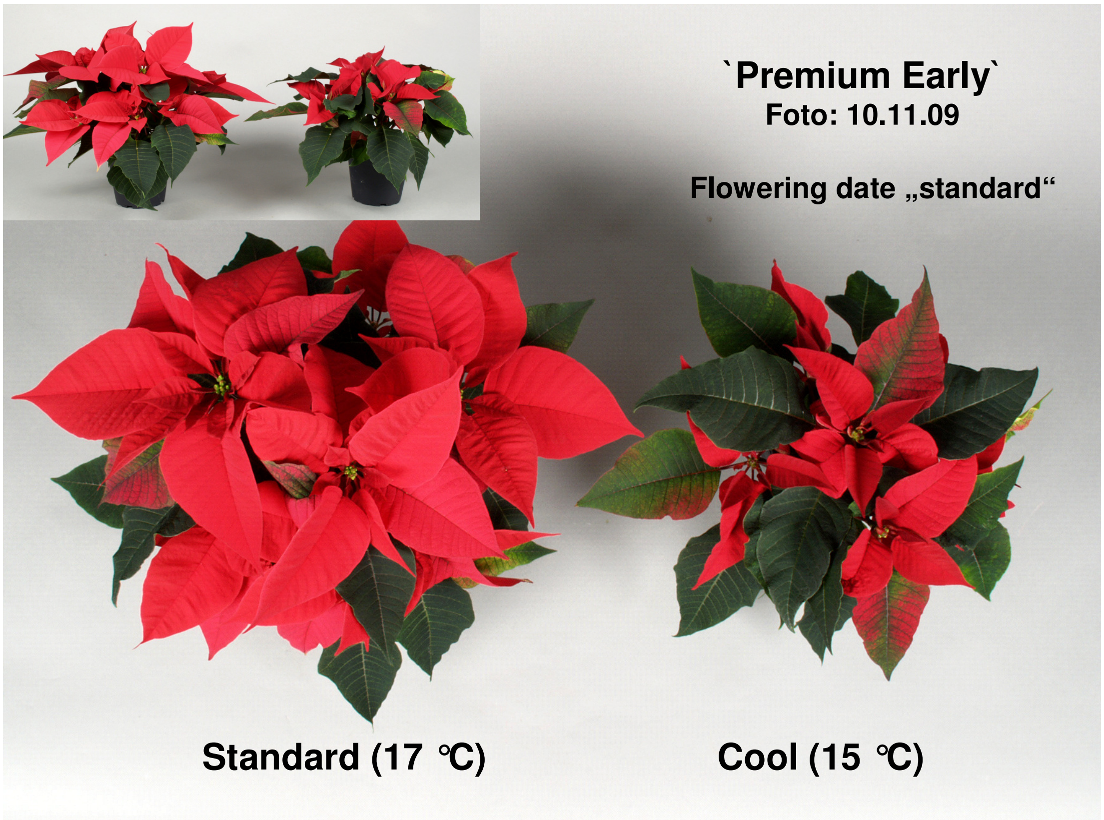
sel **'Christmas Beauty'**(8.0)	25.11.	29.11.	4
Red Fox **'Cosmo'**(8.5)	25.11.	05.12.	No market quality
sel **'Christmas Eve evol.'**	13.11.	25.11.	12
sel **'Christmas Angel'** (not available in EU)	25.11.	…	No market quality

Assessments were also made on plant quality by recoding stage of bract development, plant height, plant diameter, number of breaks and number of bracts (see Appendix II). Of the 27 varieties tested, those better suited to the cool regime are listed in table 3 with notes highlighting the key impacts of lower temperature. The photographic comparisons included in figure 4 further demonstrate the impact of the cool regime on four of the varieties tested. The photographs were taken in mid – November (10th to 13th November) when marketing of standard varieties had commenced. There was therefore up to a further 3- 4 weeks of growth possible beyond the stage illustrated before the trial ended, providing extra time for bract star development to improve.

Table 3. Summary of impact of cool growing on selected varieties tested

Group 1: Short delay (14-18 days) and minimal loss of quality	
Freedom Early (6.5)	Early, short delay, comparatively large bracts
Monreale Early Red(7.0)	Early, uniform, dark bracts and slightly too small
Prestige Early Red (7/7.5)	Early, short delay, good quality
Early Millenium (6.5)	Early, short delay, slightly non-uniform, comparatively big bracts
Christmas Carol (7.0)	Good brilliance, comparatively big bracts
Christmas Eve evol	Early, round and uniform bract stars, good quality and brilliance.
Group 2: Delay 11-21 days and slight loss of quality	
Alreddy Red (6.5)	Small bracts, non-uniform
Autumn Red (6.5/7.0)	Early non-uniform colouring
Mira Red (6.5)	Early, bracts slightly too small
Champion Red (7.5/8.0)	Comparatively dark bracts, good quality
Premium Red (7.0)	Slightly non-uniform growth and colouring, chlorotic spots
Viking Red (8.0)	Early, bracts appear grease spotted


`Early Millennium`
Foto: 10.11.09
Flowering date „standard“
Standard (17 °C)
Cool (15 °C)


`Premium Early`
Foto: 10.11.09
Flowering date „standard“
Standard (17 °C)
Cool (15 °C)

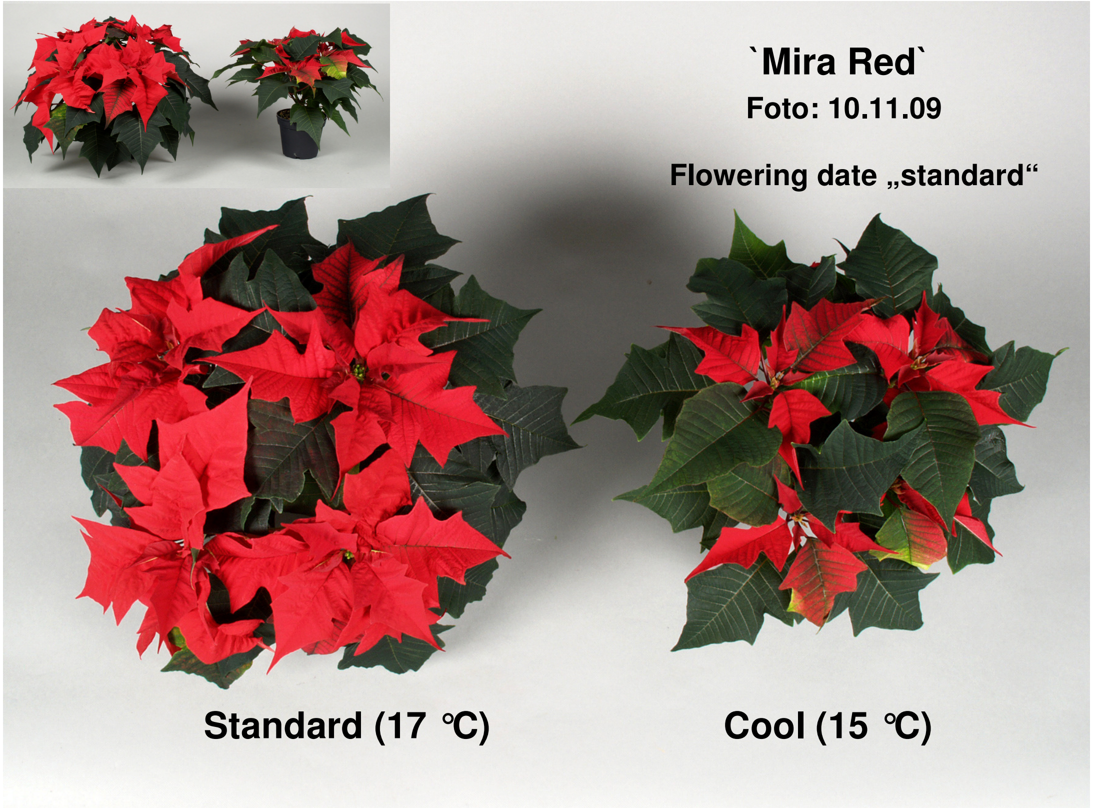


Figure 4. Photographic comparison of varieties grown in the standard and cool temperature regimes

Fuel Consumption

The climate data for the standard and cool regimes was used to estimate fuel consumption on a daily basis (Appendix III) assuming a single glass roof, an energy screen and based on a 1000m^2 glasshouse in Ahlem. These data suggests that the cool regime consumed 4.1 l/m^2 less oil for the production period overall, with these savings generated during the SD period of production when differences in set points commenced (table 4).

Table 4. Calculated fuel consumption (litres/m^2) for the standard and cool temperature regimes during the 2009 growing season at Ahlem.

	Standard	Cool Crop
Wk 29 -38	0.8	0.8
Wk 39 -48	9.6	5.5
Total	10.4	6.3

Discussion

The potential for reducing temperature for poinsettias grown with natural daylength varies with choice of variety.

Reducing temperature would be expected to slow plant development in general and hence selecting a variety with a shorter response time would appear to maximise the chances of reaching a suitable stage for marketing in time for Christmas when grown at lower temperature. In practise the shorter response group varieties (i.e. up to 6.5 weeks) developed to a suitable stage for marketing sooner when grown cool than varieties with longer response groups. However there was a longer delay resulting from lower temperature production for shorter response varieties than longer response varieties.

The aim of lower temperature production is to reduce energy use and hence cost of production. If reducing temperature delays flowering the requirements for heat inputs may be prolonged and could negate the energy saving, this will of course depend on the growing system and the use of heat for other crops.

Energy saving can be maximised through a combination of approaches and the use of thermal screens at night would further increase the energy saving achieved by reducing temperatures (ideally via temperature integration). Given the delays resulting from reducing temperature, a black out thermal screen (where available) could also be used to initiate earlier flowering, allowing more time for development before plants need to be marketed for Christmas. Earlier potting would also be required for this approach to achieve the necessary plant size prior to flowering to meet retailer specifications and hence space would need to be available earlier in the season to facilitate earlier potting. Having suitable varieties for production in such conditions would also be necessary to achieve suitable results and the trials reported here should assist with such decisions as well as provide some preliminary data as to how these varieties should be managed.

Conclusions

Response time is not necessarily linked to the extent of delay resulting from reducing production temperature, although it was the longer response varieties that failed to meet the window for marketing as a result of growing in the cooler temperature regime.

Appropriate selection of variety is essential for lower temperature production to succeed. Of the varieties tested, Freedom Early, Monreale Early Red, Prestige Early Red, Early Millenium, Christmas Carol and Christmas Eve evol were best suited to the cool regime tested in these trials.

Knowledge and Technology Transfer

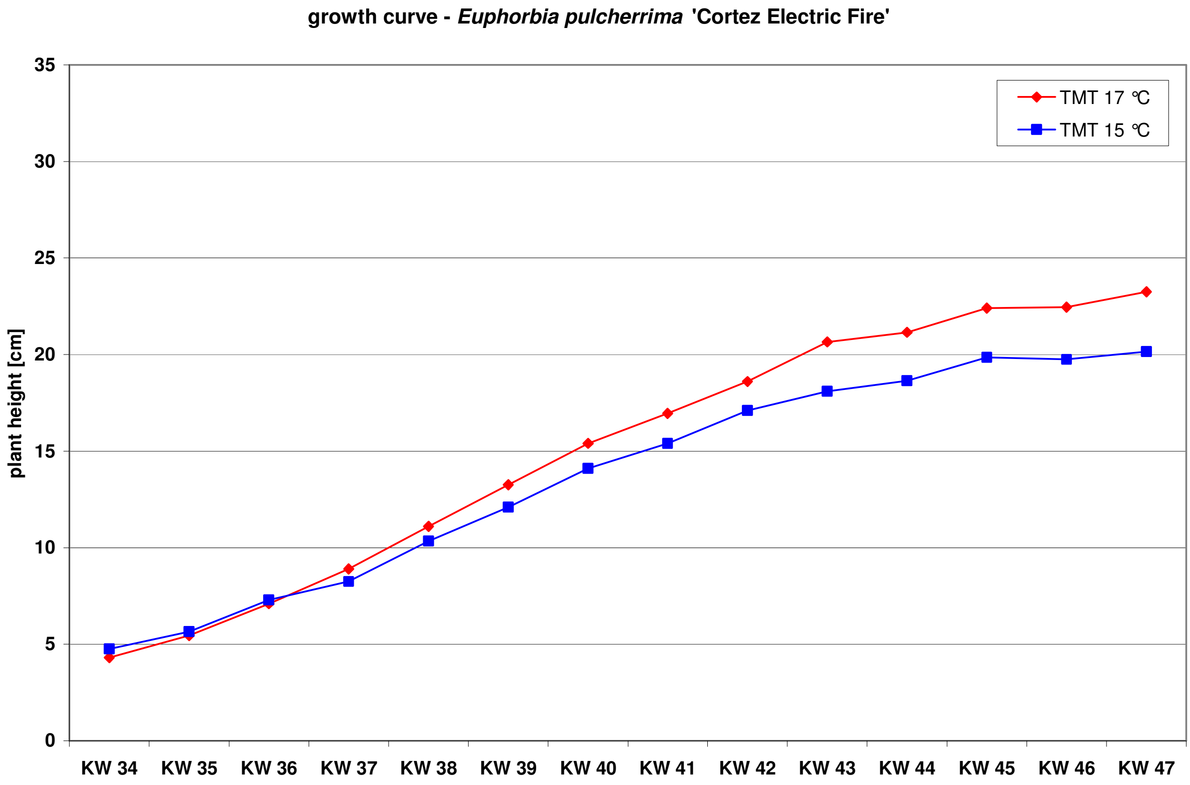
Poinsettia grower group visit to Ahlem trials November 2009.

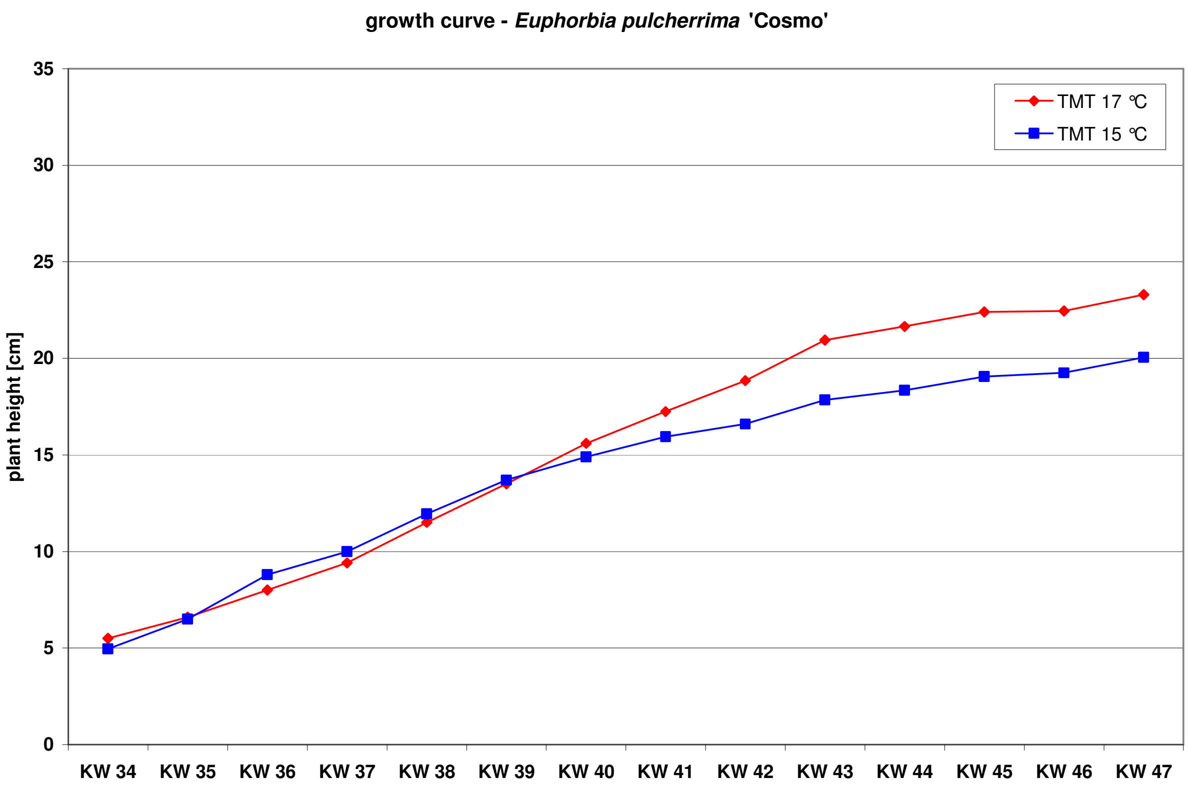
References

PC 71d Poinsettia: investigation of the impact of temperature and light during the final phase of growth and an assessment of the interaction between marketing stage and shelf-life.

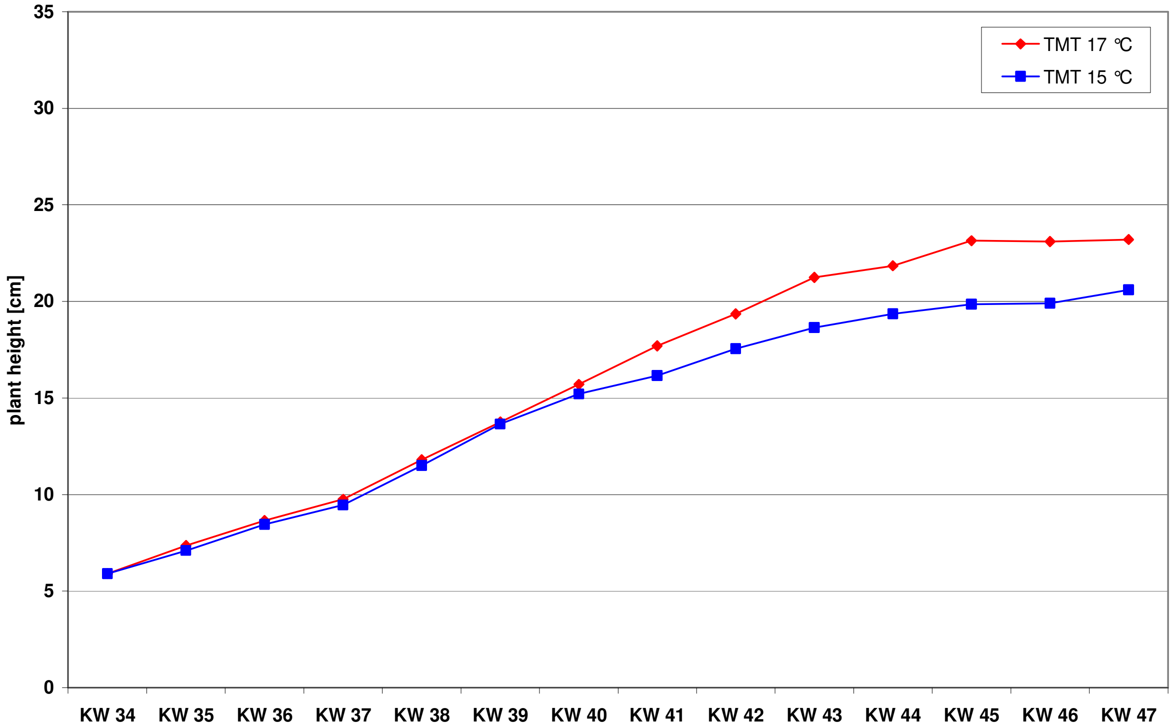
APPENDICES

Appendix I

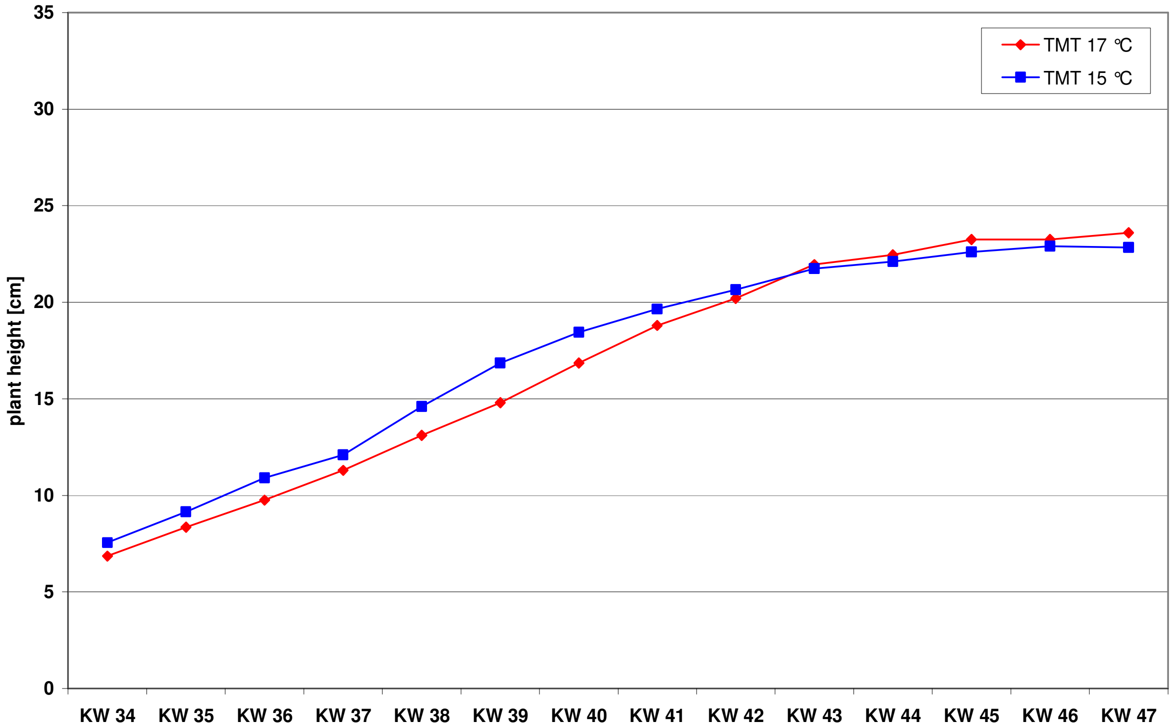




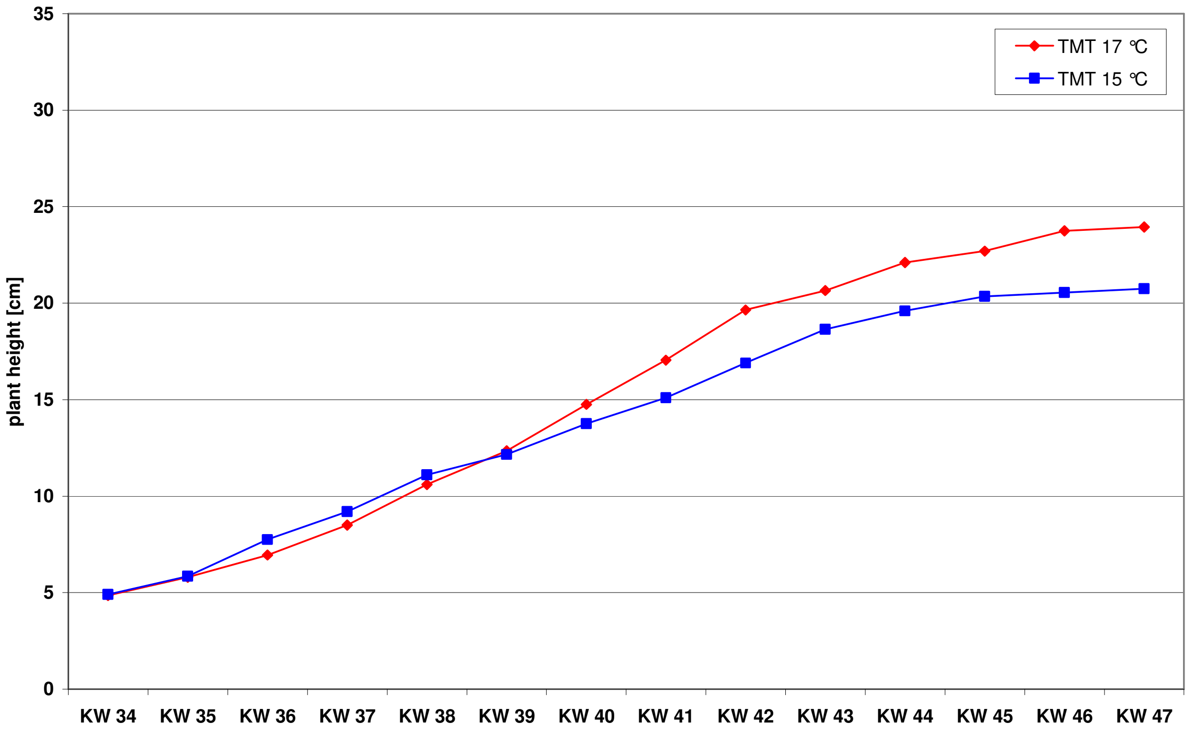
growth curve - ***Euphorbia pulcherrima*** **'Infinity Bright Red'**



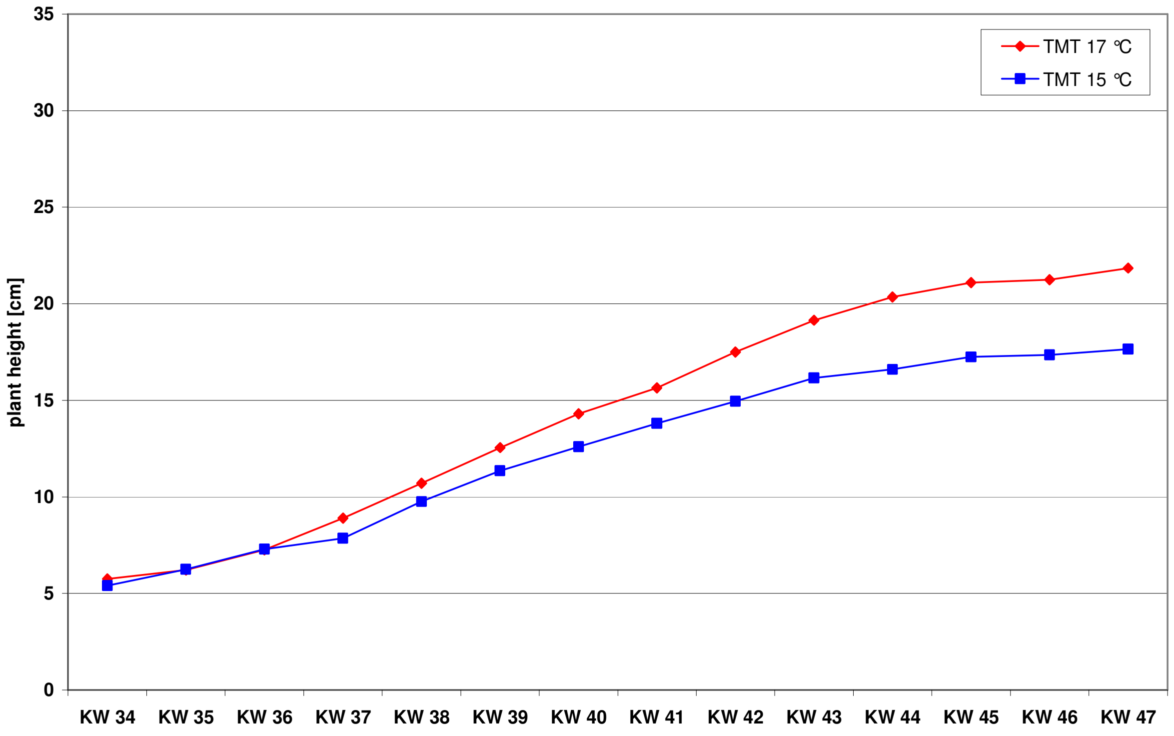
growth curve - ***Euphorbia pulcherrima*** **'Infinity Red'**

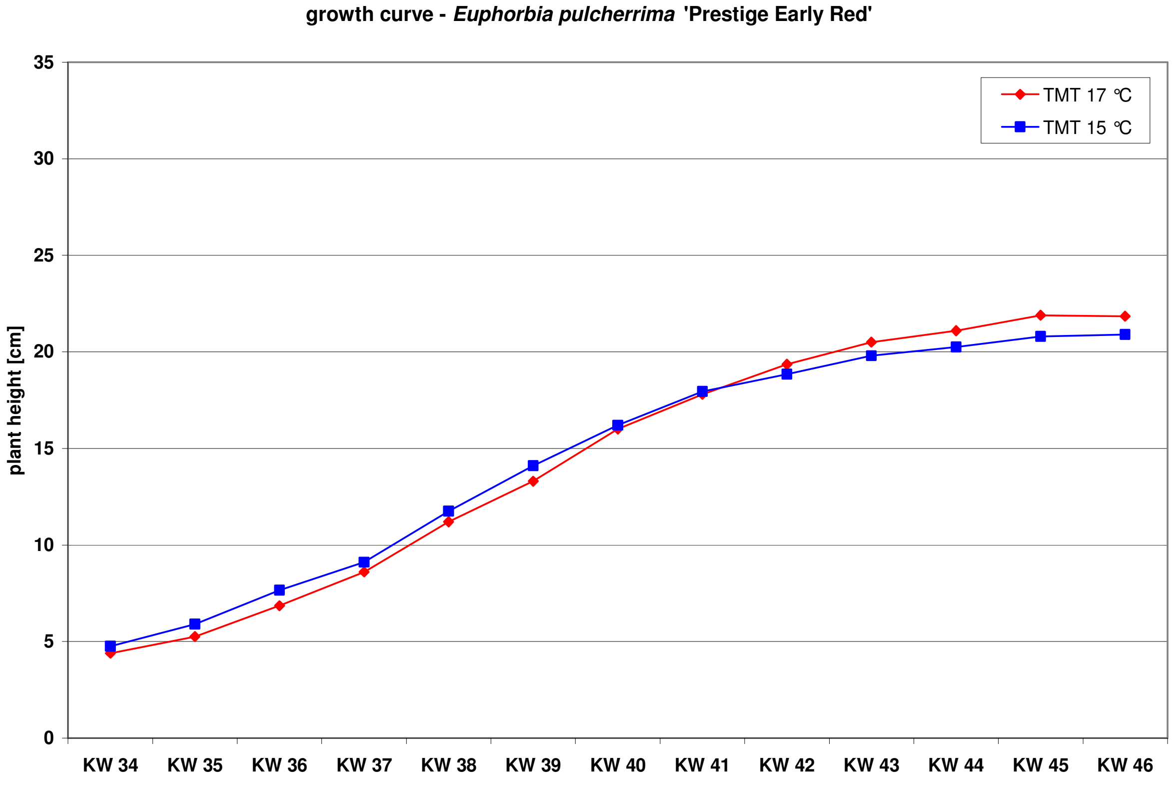


growth curve - *Euphorbia pulcherrima* 'Mars improved'



growth curve - *Euphorbia pulcherrima* 'Premium Red'




growth curve - *Euphorbia pulcherrima* 'Prestige Early Red'
plant height [cm]
35
30
25
20
15
10
5
0
KW 34
KW 35
KW 36
KW 37
KW 38
KW 39
KW 40
KW 41
KW 42
KW 43
KW 44
KW 45
KW 46
TMT 17 °C
TMT 15 °C

Appendix II

Flowering date and growth parameters of different poinsettia cultivars and different heating temperatures, trial 2009:

Variety	Flowering date		Plant height (cm)				Plant diameter (cm)				Diameter of 2 bracts per plant (cm)				No. of decorating stems			
	TMT 17 °C	TMT 15 °C	TMT 17 °C		TMT 15 °C		TMT 17 °C		TMT 15 °C		TMT 17 °C		TMT 15 °C		TMT 17 °C		TMT 15 °C	
			x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*
'Premium Early'	04.11.	25.11.	20,4	*1,7*	17,9	*1,1*	42,9	*4,0*	37,2	*3,0*	23,7	*2,9*	17,8	*1,8*	5,7	*0,7*	5,5	*0,8*
'Autumn Red'	09.11.	27.11.	26,8	*2,3*	28,9	*3,0*	50,3	*4,9*	49,0	*4,3*	26,2	*2,9*	21,6	*3,6*	5,7	*1,0*	5,7	*1,2*
'Early Millennium'	09.11.	25.11.	25,7	*1,5*	23,8	*1,5*	48,1	*4,3*	42,9	*3,4*	26,0	*3,7*	26,0	*2,5*	4,9	*1,0*	5,2	*0,9*
'Freedom Early'	09.11.	25.11.	26,7	*1,3*	22,1	*5,9*	45,2	*4,2*	40,8	*3,2*	23,5	*2,9*	19,1	*2,5*	4,6	*1,1*	3,3	*1,2*
'Mira Red'	11.11.	25.11.	24,7	*1,8*	23,3	*1,0*	45,0	*3,4*	42,6	*4,3*	21,5	*2,4*	20,5	*2,4*	4,9	*0,8*	5,1	*0,7*
'Christmas Eve'	13.11.	25.11.	27,3	*1,8*	28,3	*1,6*	47,4	*3,2*	46,6	*3,4*	20,9	*2,2*	19,1	*1,3*	6,3	*0,8*	5,6	*0,7*
'Fiamma'	13.11.	27.11.	26,0	*1,9*	27,3	*2,2*	47,9	*6,1*	45,7	*4,3*	21,6	*2,3*	19,8	*2,4*	5,9	*0,8*	5,6	*0,8*
'Monreale Early Red'	13.11.	01.12.	25,9	*1,8*	23,2	*2,2*	48,4	*3,7*	42,6	*2,8*	21,9	*2,4*	17,0	*2,5*	4,9	*0,7*	4,8	*0,9*
'Prestige Early'	13.11.	27.11.	26,7	*2,0*	28,9	*1,9*	49,5	*4,0*	46,2	*2,9*	21,6	*2,5*	21,1	*2,6*	5,9	*0,6*	4,7	*1,0*
'Alreddy Red'	16.11.	01.12.	26,8	*2,2*	24,9	*2,2*	55,5	*6,5*	46,5	*2,7*	23,7	*2,8*	16,1	*2,2*	5,7	*0,6*	5,1	*1,0*
'Christmas Carol'	16.11.	01.12.	29,7	*1,5*	26,3	*1,1*	56,8	*5,0*	48,5	*4,0*	22,6	*2,9*	16,3	*1,8*	6,0	*0,7*	6,1	*0,8*
'Cortez Electric Fire'	20.11.	n.e.	26,3	*1,5*	24,0	*1,7*	60,3	*5,4*	51,3	*4,7*	22,2	*2,0*	17,4	*2,3*	5,7	*0,7*	5,1	*1,1*
'Premium Red'	17.11.	05.12.	25,9	*1,5*	22,5	*1,6*	50,7	*4,4*	45,3	*3,3*	22,7	*2,1*	16,0	*2,5*	5,4	*0,8*	6,2	*0,6*
'Viking Red'	20.11.	01.12.	29,5	*1,3*	27,8	*1,5*	48,3	*4,4*	42,2	*3,4*	22,7	*2,2*	19,2	*1,7*	5,5	*0,8*	4,0	*1,6*
'Allegra'	23.11.	01.12.	25,8	*1,1*	23,3	*1,9*	48,7	*4,0*	47,0	*3,4*	22,2	*2,1*	19,6	*1,9*	4,8	*0,6*	5,2	*1,2*

Flowering date and growth parameters of different poinsettia cultivars and different heating temperatures, trial 2009:

Variety	Flowering date		Plant height (cm)				Plant diameter (cm)				Diameter of 2 bracts per plant (cm)				No. of decorating stems			
	TMT	TMT	TMT 17 °C		TMT 15 °C		TMT 17 °C		TMT 15 °C		TMT 17 °C		TMT 15 °C		TMT 17 °C		TMT 15 °C	
	17 °C	15 °C	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*	x	*stabw*
'Mars improved'	23.11.	01.12.	29,5	*2,3*	26,9	*1,8*	50,5	*5,2*	45,1	*4,4*	20,3	*2,0*	17,9	*1,8*	6,0	*0,4*	5,5	*1,1*
'Stargazer Red'	23.11.	05.12.	29,3	*2,2*	28,1	*2,0*	53,7	*3,2*	48,1	*4,5*	22,1	*1,6*	17,2	*2,0*	5,3	*0,7*	5,9	*0,9*
'Champion Red'	25.11.	10.12.	26,1	*1,6*	24,2	*1,7*	50,9	*5,3*	43,6	*3,8*	22,6	*2,1*	16,5	*1,6*	5,8	*0,7*	5,9	*0,6*
'Christmas Angel'	25.11.	n.e.	30,5	*2,5*	25,9	*1,7*	53,4	*3,3*	45,3	*3,5*	22,5	*2,1*	16,3	*1,7*	5,9	*0,4*	5,9	*0,6*
'Christmas Beauty' (SK 62)	25.11.	29.11.	24,3	*1,7*	24,2	*1,9*	44,3	*3,6*	43,9	*3,2*	19,8	*1,7*	19,0	*2,0*	4,9	*0,7*	5,8	*0,8*
'Christmas Day' (SK 64)	25.11.	29.11.	26,1	*1,3*	25,9	*0,9*	49,0	*3,6*	49,5	*4,6*	21,6	*2,2*	20,4	*2,2*	5,3	*0,8*	5,9	*0,8*
'Cosmo Red'	25.11.	n.e.	29,7	*1,8*	25,8	*1,1*	58,2	*3,9*	50,6	*3,7*	22,8	*2,5*	17,3	*2,4*	6,5	*0,5*	6,5	*1,0*
'EarlyGlory Red'	25.11.	08.12.	28,9	*1,8*	26,8	*2,3*	51,4	*4,0*	45,7	*3,9*	22,7	*2,3*	17,0	*2,1*	5,5	*1,0*	4,6	*0,8*
'Happy Christmas evol.' (SK 65)	25.11.	07.12.	25,7	*2,4*	25,0	*1,5*	44,3	*3,7*	43,3	*4,0*	18,2	*1,6*	18,4	*1,5*	5,4	*0,7*	5,8	*0,5*
'Infinity Bright Red'	25.11.	n.e.	28,8	*1,6*	24,9	*1,8*	54,6	*2,8*	47,4	*3,5*	22,2	*2,0*	14,4	*2,2*	5,3	*0,5*	5,4	*1,0*
'Infinity Red'	25.11.	n.e.	30,5	*1,6*	26,6	*2,2*	54,9	*4,0*	46,5	*5,6*	23,0	*2,4*	16,0	*1,8*	5,7	*0,5*	5,7	*0,8*
'Noel' (SK 67)	25.11.	07.12.	25,3	*1,2*	24,8	*1,1*	44,9	*2,9*	44,4	*3,8*	20,0	*3,1*	18,8	*2,3*	5,1	*0,6*	5,6	*0,9*

Appendix III

Oil consumption per day (liter per 100 m²) with different setpoints during short day (climate data Hanover-Ahlem 2009); Standard: 18 / 16 °C HT, 20 °C LT, CoolCrop: 15 / 13 °C HT, 17 °C LT

Day	Standard	CoolCrop
01.11.	16,0	9,5
02.11.	15,7	8,2
03.11.	14,2	7,5
04.11.	19,8	12,2
05.11.	19,4	11,9
06.11.	15,3	7,5
07.11.	21,3	13,3
08.11.	18,1	11,0
09.11.	28,2	20,2
10.11.	28,4	20,9
11.11.	25,5	18,0
12.11.	24,5	17,0
13.11.	17,1	9,6
14.11.	10,3	2,9
15.11.	11,6	5,1
16.11.	18,1	10,6
17.11.	12,5	5,0
18.11.	12,0	4,6
19.11.	7,5	2,4
20.11.	6,2	2,4
21.11.	6,5	1,4
22.11.	9,7	2,1
23.11.	17,4	9,4
24.11.	13,1	6,5
25.11.	7,7	1,6
26.11.	12,7	5,4
27.11.	20,4	13,1
28.11.	20,0	12,2

29.11.	12,9	7,8
30.11.	21,2	14,1
01.12.	30,4	22,7
02.12.	31,2	23,5
03.12.	20,5	13,4
04.12.	25,4	18,3
05.12.	30,6	23,5
06.12.	17,7	10,8
07.12.	17,7	10,7
08.12.	24,6	17,6
09.12.	21,6	13,9
10.12.	23,9	15,6
11.12.	28,3	20,6
12.12.	33,7	26,6
13.12.	41,0	33,9
14.12.	42,8	35,7
15.12.	38,6	30,9
16.12.	40,1	31,8
17.12.	44,5	36,2
18.12.	55,5	47,8
19.12.	67,4	60,3
20.12.	62,1	55,0
21.12.	38,5	31,4
22.12.	36,9	29,9
23.12.	32,4	25,3
24.12.	40,6	33,5
25.12.	32,7	25,7
26.12.	24,6	16,9
27.12.	28,9	21,2
28.12.	30,4	23,3
29.12.	39,1	32,0
0.12.	42,9	35,8
31.12.	44,2	37,1