

**Project title:** The Bedding and Pot Plant Centre – new product opportunities for bedding and pot plant growers

**Objective 5:** *To evaluate the shelf life performance of micro-propagated Hellebores produced as pot plants for pre-Christmas marketing.*

**Project number:** PO 019a

**Project leader:** Dr Jill England, ADAS Boxworth

**Report:** Annual report, 31 March 2018

**Previous report:** None

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**Date project commenced:** 1 April 2017

**Date project completed** 31 March 2019

**(or expected completion date):**

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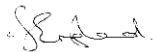
## AUTHENTICATION

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.

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Signature

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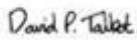
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## Grower Summary

### Headline

- Hellebore 'Royal Emma', being the last variety to flower, was the best performing variety under shelf life conditions, and with sustained bud and flower production and a seven day timeframe for progression from bud to open flower, showed most promise as a house plant.
- To complement poinsettia sales from late November, 'Royal Emma' was close to minimum flower/bud specifications in the year it was examined.
- Earlier flowering/sales periods can be achieved with the other varieties examined.

### Background

The Bedding and Pot Plant Centre (BPPC) has been established to address the needs of the industry via a programme of work to trial and demonstrate new product opportunities and practical solutions to problems encountered on nurseries. Knowledge transfer events including trial open days and study tours are also included in the programme.

The work programme is guided by a grower-led Management Group that includes members of the BPOA Technical Committee, and representatives from Baginton Nurseries, Coventry the host nursery for the BPPC, and growers representing both the bedding and pot plant sectors.

*This is the Bedding and Pot Plant Centre report for:*

**Objective 5:** *To evaluate the shelf life performance of micro-propagated Hellebores produced as pot plants for pre-Christmas marketing.*

### Summary

The ideal Hellebore variety for pot plant production has an upright growth habit, with flowers that face upwards (Hellebore flowers tend to face downwards). For some Hellebores, including white varieties, flower colour can fade dramatically. While appreciation of colour change may be subjective, it can detract from the overall appearance in some varieties, impacting on sales. In order to investigate flower colour longevity in Hellebores as pot plants during shelf life, and identify any quality issues that may develop in these high value products, a trial was carried out between April 2017 and January 2018.

Forty plug plants of five micro-propagated Hellebore varieties (HGC 'Wintergold' and HGC 'Jesko', from Heuger; 'Royal Emma' from Just Must Perennials; and 'St Antonia' and 'St Lucia'

from Bock) were transplanted into 1.5L terracotta coloured plastic pots in week 16, and established within a polythene tunnel until week 21, when they were moved outdoors.

Only four of the varieties were placed into the first shelf life trial commencing week 47 to week 1 ('Royal Emma' was not yet in flower). Four plants per variety were put into shelf life conditions in the next trial, commencing week 1, 2018 (04.01.18) (20°C, 12 hour day/night, 1000 lux light), where they remained until week 4 (25.01.18). The plants were assessed twice per week, buds were tagged at each assessment date and photographs of buds and flowers were taken. The number of buds and open flowers were also recorded.

HGC 'Wintergold' and HGC 'Jesko' were the first varieties to flower, with the first flowers opening in weeks 25 and 36 respectively. All plants of these varieties were in flower by the start of the shelf life test. Old flowers were removed to encourage bud development, but few new buds were produced during the second shelf life test. Once the plants were moved into shelf life conditions, the flowers on both HGC 'Wintergold' and HGC 'Jesko' turned green very quickly, with the HGC 'Jesko' flowers developing a mottled appearance. Both varieties lost quality in shelf life with yellowing to the lower leaves by week 4, and flower stems that were starting to wilt (**Figure 1**). Such quality loss would be expected with the earlier flowering varieties.

'St. Antonia' and 'St. Lucia' produced many white flowers whilst outside. When transferred into shelf life conditions, petal colour faded after approximately 11 days. The plants produced few buds once in the shelf life conditions, and so flowering was short-lived.

'Royal Emma' was the last variety to flower, and as a result performed well in the second shelf life test. This variety produced significantly more buds than all other varieties throughout the shelf life test. Although the flower petals turned green after approximately 11 days, the plants continued to produce buds, and flowered for longer than the other varieties.

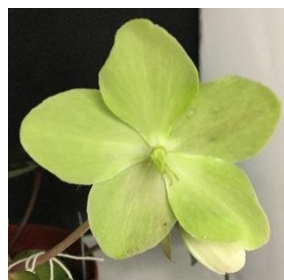
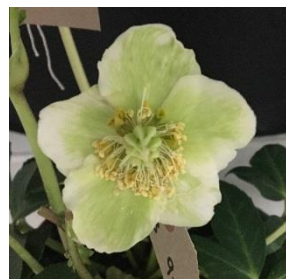
Overall, under the conditions of this trial, 'Royal Emma' was the best performing variety, with all plants consistently floriferous with many buds, maintaining quality for the duration of the shelf life test. At seven days, progression from bud to open flower took longer than for other varieties. However, to complement poinsettia sales from late November, 'Royal Emma' was close to minimum flower/bud specifications in this particular trial, and perhaps an earlier flowering variety may be more suited.

The remaining four varieties performed well under cooler conditions outdoors, where flower colour was maintained and many flowers were present, but this was short-lived once the plants were moved into shelf life conditions, possibly as a result of the earlier flowering period.



**Figure 1.** Flower development and colour change from the start of the shelf life test (04.01.18) until week 4 (25.01.18) – continued overleaf







## Financial benefits

This work with Hellebores will potentially broaden the range of plants in flower for the pre-Christmas marketing window to compliment Poinsettia, given appropriate variety selection for key house plant attributes (such as flowers facing upwards, attractive foliage as well as flowers, minimal stamen drop etc.). Consumers have the option to purchase Hellebores during this period, display them as a house plant and then subsequently plant them in the garden rather than disposing of them at the end of the season (as they would for Poinsettia).

Sold as pot plants in flower, some Hellebore varieties can demand high retail prices with a 10% premium over green plants. Current retail prices for some of the varieties used in this trial include: *Helleborus* 'Royal Emma' - £13.50 (1.5 L); *Helleborus* 'Wintergold' - £8.50 – £14.99 (2 L); *Helleborus* HGC 'Jesko' - £8.50 (2 L).

## Action points

- Schedule production to ensure plants produce the main flush of buds during target marketing period to maximise flowering in retail/post-sales phase.
- Lower temperatures where possible during retail to help maintain flower colour for longer.
- Consider earlier marketing for most of the varieties tested. Apart from 'Royal Emma', the varieties examined were producing open flowers by week 44 (01.11.17).

## Science Section

### Introduction

The Bedding and Pot Plant Centre (BPPC) has been established to address the needs of the industry via a programme of work to trial and demonstrate new product opportunities and practical solutions to problems encountered on nurseries. Knowledge transfer events including trial open days and study tours were also included in the programme.

The work programme is guided by a grower-led Management Group that includes members of the BPOA Technical Committee and representatives from Baginton Nurseries, Coventry the central host nursery for the BPPC. The agreed objectives for the Bedding and Pot Plant Centre, 2017-18 were:

**Objective 1:** To evaluate a range of plant growth regulators (PGRs) either approved in the UK or in other European Countries for use on bedding and pot plants (spray and drench application).

**Objective 2:** To evaluate a range of products alone or in combination, to increase the success rate and reduce rooting time when striking un-rooted cuttings. This is a continuation of work carried out in 2016.

**Objective 3:** To evaluate plant nutrition, water quality, irrigation regime and environment as possible causes of necrotic spotting and associated symptoms in susceptible *Verbena* varieties. This is a continuation of work carried out in 2016.

**Objective 4:** To extend the marketing season for coloured varieties of pot-grown Hellebore to include the months prior to the New Year through cool treatments.

**Objective 5:** To evaluate the shelf life performance of micro-propagated Hellebores produced as pot plants for pre-Christmas marketing.

**Objective 6:** To evaluate a range of plant growth regulators (PGRs) and fungicides either approved in the UK or in other European countries for spray application on Poinsettia.

*This is the Bedding and Pot Plant Centre report for Objective 5.*

### Background

The pre-Christmas market for Hellebores produced as pot plants has expanded in recent years, particularly as new seed and micro-propagated varieties have become available that flower before Christmas. Maintaining plant quality during shelf life (i.e. during retail) is critical when producing and marketing pot Hellebores.

The ideal Hellebore variety for pot plant production has an upright growth habit, with flowers that face upwards (Hellebore flowers tend to face downwards). For some Hellebores, including white varieties, flower colour can fade dramatically. Whilst appreciation of colour change may be subjective, it can detract from the overall appearance in some varieties, impacting on sales.

The retail price of Hellebores as pot plants (**Table 1**) needs to be sufficient to account for the cost of the initial plant material (particularly micro-propagated varieties) and the relatively long production period (around 38 weeks) whilst delivering the required profit. Consumers also need to be confident that they are getting value for money when purchasing a Hellebore as a pot plant, and so shelf life is important to ensure that flower colour will be maintained for a prolonged period of time.

**Table 1.** Example Hellebore retail prices

Variety	Retail price range (2017)
<i>Helleborus</i> 'Royal Emma'	£13.50 (1.5 L pot)
<i>Helleborus</i> HGC 'Wintergold'	£8.50 - £14.99 (2 L pot)
<i>Helleborus</i> 'HGC 'Jesko'	£8.50 (2 L pot)

The investigation into flower colour longevity in Hellebores during shelf life will chart plant performance during shelf life and identify any quality issues that may develop in these high value products. The output will inform grower decisions when developing new product lines and cultivar choice, whilst also demonstrating the opportunity that the new micro-propagated Hellebore cultivars may present as a new product for the pre-Christmas market.

## Project objectives

**Objective 5:** To evaluate the shelf life performance of micro-propagated Hellebores produced as pot plants for pre-Christmas marketing.

## Methods and materials

### *Site and crop production details*

The Hellebore trial was carried out between April 2017 and January 2018. Forty plug plants of five micro-propagated Hellebore varieties (**Table 2**) were delivered to Baginton Nurseries in week 15, transplanted into 1.5L terracotta plastic coloured pots (week 16), and placed within a polythene tunnel in a randomised block design (10 plants/plot, four replications) until week 21. Growing media was supplied by Bulrush Horticulture (70% Bulrush peat, 30% Forest Gold;

Nutricote 100 day (16-10-10, 2 kg/m<sup>3</sup>), Plantacote 12 month (18-06-12, 2 kg/m<sup>3</sup>), base fertiliser (15-10-20, 0.5 kg/m<sup>3</sup>), Add-N (0.3 kg/m<sup>3</sup>), lime/dolodust (4.5 kg/m<sup>3</sup>)). The trial was moved outside in week 21 onto a hardstanding area, with green shade netting overhead for protection from strong sunlight (**Figure 2**). The plants were provided with overhead irrigation and temperature and humidity were recorded every 30 minutes using a Tinytag data logger.

**Table 2.** Hellebore varieties used in the shelf life performance trial, 2017

Variety No.	Variety	Supplier
1	HGC 'Wintergold'	Heuger
2	HGC 'Jesko'	Heuger
3	'Royal Emma'	Just Must Perennials
4	'St Antonia'	Bock
5	'St Lucia'	Bock



**Figure 2.** Hellebore plants set out in a randomised plot design, outdoors, at Baginton Nurseries

All plants were transported to ADAS Boxworth in week 44, where they were set down on a shaded (green shade netting) standing out area. The first shelf life test ran from week 47 until week 1, 2018. Five plants of each variety (apart from 'Royal Emma' as these had not yet produced flowers) were moved into the shelf life room (20°C, 12 hour day / night, 1000 lux light). Plants were set down on the bench in a randomised block design with one plant per plot (**Figure 3**). The plants were stood in saucers and irrigated from below for the duration of the

shelf life test. Temperature and humidity within the shelf life room was recorded every 30 minutes using a Tinytag data logger.



**Figure 3.** Hellebore plants placed in the shelf life room at ADAS Boxworth

Additionally in week 47, half of the trial was moved into a glasshouse (set to 17°C) as an indoor control, and the rest of the trial remained outside. Temperature and humidity within the glasshouse were recorded every 30 minutes using a Tinytag data logger.

A second shelf life test was set up in week 1 2018, and ran until week 4. This time 'Royal Emma' was included as these plants were now in flower. The same set up process was followed as for shelf life test one, except four plants per variety were selected.

The trial was monitored for pest and disease throughout, and biological control (*Aphidius ervi*) was introduced into the glasshouse and the shelf life room from week 47 for aphid control.

Plant movements were as summarised in **Table3**.

**Table 3.** Hellebore plant movements during 2017-2018

Date	Action
Week 15	Delivery to Baginton Nurseries. Plants placed in prop house
Week 16 (19/04/17)	Plants potted and placed within a polythene tunnel
Week 21 (23/05/17)	Plants placed outside with shade netting overhead
Week 44 (01/11/17)	Plants moved to ADAS Boxworth. Shade netting placed over trial
Week 47 (21/11/17)	First shelf life test set up
Week 47 (24/11/17)	Half of the trial moved into the glasshouse
Week 1 (04/01/18)	First shelf life test ends, second shelf life test set up
Week 4 (25/01/18)	Second shelf life test ends

### *Trial design and statistical analysis*

At the beginning of the trial, varieties were arranged in a fully randomised plot design with five varieties x four replicate blocks and 10 plants per plot. This gave a total of 40 plants per variety.

For the first shelf life treatment, five plants per variety which were in flower were selected at random, from the main trial, and re-arranged in the shelf life room, with one plant per plot, and five replicates.

The plants that remained outside were divided into two batches, so that half of each plot was moved into the glasshouse.

For the second shelf life treatment, four plants per variety which were in flower were selected at random, from the outdoor plants, and re-arranged in the shelf life room, with one plant per plot, and four replicates.

Results were examined by ANOVA with use of Duncan's multiple range test to separate treatments.

### *Assessments*

The plants were assessed prior to transplant for plant quality, height and root development on a sub-sample of plugs. Plants were monitored for date of flowering, and the number of plants with buds and open flowers was recorded in weeks 44, 45 and 46. Once in the shelf life room, the plants were assessed twice per week for the number of buds and open flowers per plant. Buds were tagged and photographed, so that the time taken from buds opening to flowers discolouring could be recorded.



## Results

The varieties included in this trial were selected for their outward/upward facing flowers held above the dark green foliage.

### *Pre-transplant*

On arrival at Baginton Nurseries, all plants were of good quality, with no signs of damage due to transportation. There was a small amount of *Botrytis* visible on some HGC 'Wintergold', and the affected leaves were removed prior to transplant. All plants were developing good strong roots with root hairs, which were filling the plugs. There was a size difference between the varieties, HGC 'Wintergold' plants were the largest, and 'St. Antonia' the smallest (**Table 4** and **Figure 4**).

**Table 4.** Hellebore plug sizes prior to transplant, week 16 2017

Variety	Average plant size (mm)
HGC 'Wintergold'	102.2
HGC 'Jesko'	74.6
'Royal Emma'	85.6
'St Antonia'	48.2
'St Lucia'	67.6



**Figure 4.** Plugs of HGC 'Wintergold' (left) and 'St. Antonia' (right) prior to potting

### *Flowering – pre-shelf life test*

The trial was monitored throughout for flowering and plant quality. In week 25 (19 June 2017), it was noted that two of the HGC 'Wintergold' plants had collapsed and died (these were removed from the trial), while others had started to produce open flowers. By week 27, 18 of the remaining 38 HGC 'Wintergold' were in flower, although no more plants were showing

signs of collapsing. In week 29, existing flowers were removed from the plants to encourage more buds to develop. None of the other varieties were in flower at this point.

In week 36, HGC 'Jesko' had buds showing colour in all pots, and flowers were starting to open on 10 of the 40 plants. By week 42, the majority of the HGC 'Jesko' were in flower, and some of the HGC 'Wintergold' were producing more flowers.

A full assessment was completed on all plots for the number of plants with buds, and the number of plants with open flowers in weeks 44, 45 and 46 (**Table 5**).

**Table 5.** Number of plants with fully open flowers or buds showing colour, assessed week 44 (01.11.17), week 45 (09.11.17) and week 46 (17.11.17)

Variety	Week 44		Week 45		Week 46	
	Flowers	Buds	Flowers	Buds	Flowers	Buds
HGC 'Wintergold' (38 plants)	13	21	17	19	19	19
HGC 'Jesko' (40 plants)	40	0	40	0	40	0
'Royal Emma' (20 plants)	1	3	1	3	1	4
'St Antonia' (40 plants)	6	33	7	32	10	30
'St Lucia' (40 plants)	5	31	11	27	15	23

### *Shelf life test 1*

#### Shelf life test 1

The first shelf life test, set up in week 47, was used to establish the methodology for plant management and frequency of assessments, and included all varieties except for 'Royal Emma', which had not started to flower.

Once the plants were in shelf life conditions, the older, faded flowers were not removed, and few new flowers or buds were produced. This was adjusted for the second shelf life test (set up in week 1, 2018, when 'Royal Emma' was flowering), when older, faded flowers were removed throughout the shelf life period to encourage bud and flower development.

For the first shelf life test, plants were assessed on a weekly basis, but this was increased to two assessments each week for the second test (as a result the records from the first shelf life assessment did not capture flower deterioration in sufficient detail).

### *Outdoor and Glasshouse control*

In week 47 (24.11.17), 15 plants of each variety (apart from 'Royal Emma') were moved into a glasshouse to determine the timeframe for flower colour to turn green under glass. By week 48, all plants of each variety were flowering, and very few new buds were being produced. By week 49, the majority of the flowers in all varieties had turned green, and the quality was deteriorating. The flowers in the outdoor control however remained white, and the plants were still producing buds.

### *Shelf life test 2*

At the start of the second shelf life test (week 1, 2018), all varieties were in flower. Plants selected to go into the shelf life room had a mixture of open flowers and coloured buds (from those remaining outdoors). Older, faded flowers were recorded and removed to encourage further bud development. HGC 'Wintergold', HGC 'Jesko' and 'St. Antonia' were almost at pot cover, with some tall flower stems. 'Royal Emma' was compact and along with 'St. Lucia', had not quite achieved pot cover.

HGC 'Jesko' had significantly more open flowers than all other varieties ( $p < .001$ ), (**Table 6**) at the start of the shelf life test (and therefore most flowers removed) whilst 'Royal Emma' had fewest open flowers. However, 'Royal Emma' had significantly more coloured buds (12.75 per plant;  $p = 0.005$ ) than any other variety.

HGC 'Wintergold' also had significantly more open flowers than other varieties early on in the shelf life test, and significantly more were removed. By week 2 (11.01.18), the HGC 'Wintergold' flowers were discolouring very quickly.

From week 3 (15.01.18) onwards, the number of flowers removed for each variety was no longer significant. However, 'Royal Emma' continued to produce flowers, with significantly more open flowers (7.50 per plant) in week 3 (**Table 6**). The quality of HGC 'Wintergold' plants was beginning to deteriorate, with the lower leaves turning yellow and some flower stems starting to wilt.

At the final assessment on 25.01.18, 'Royal Emma' had the greatest number of open flowers (7.75 per plant) and this was significantly more than 'St. Antonia' (3.25 per plant) and HGC 'Jesko' (3.75 per plant;  $p = 0.112$ ). In terms of plant quality, 'Royal Emma' had the best quality, with plenty of flower buds present, as well as open flowers.

**Table 6.** Number of plants with buds (B), fully open flowers (F) and the number of flowers removed (R) at each assessment date

V	04.01.18			08.01.18			11.01.18			15.01.18			19.01.18			22.01.18			25.01.18	
	B	F	R	B	F	R	B	F	R	B	F	R	B	F	R	B	F	R	B	F
W	8.25	5.00	3.25	2.00	11.50	2.25	1.50	11.25	6.25	1.00	5.00	0.75	1.00	4.75	0.50	0.50	4.75	0.50	0.50	4.50
J	5.25	10.50	8.50	1.50	6.00	0.75	0.25	7.50	3.50	0.00	4.00	0.50	0.25	3.75*	0.00	0.25	3.75	0.00	0.25	3.75*
RE	12.75	2.00	2.00	12.50	1.75	0.00*	9.75	4.25*	1.00*	9.50	6.25	0.00	13.00	7.50	1.00	13.50	7.00	0.25	14.00	7.75
SA	4.75	5.00	4.25	2.50	4.50	1.50	1.75	5.00*	1.25*	1.00	4.25	1.25	0.25	4.50	1.75	0.50	3.25	0.00	0.50	3.25*
SL	6.00	2.75	2.50	3.50	5.50	0.25*	2.00	6.75	2.25	1.00	6.50	1.75	1.75	5.25	1.50	0.75	4.25	0.25	0.75	5.00
s.e.d	1.81	1.31	1.39	2.01	2.39	0.83	1.80	2.09	1.83	1.54	1.45	0.87	1.24	1.53	0.85	1.57	1.73	0.39	1.06	1.62
F pr	0.005	<.001	0.004	<.001	0.020	0.102	0.001	0.044	0.079	<.001	0.346	0.362	<.001	0.209	0.288	<.001	0.286	0.691	<.001	0.112

Assessed week 1 (04.01.18), week 2 (08.01.18 and 11.01.18), week 3 (15.01.18 and 19.01.18) and week 4 (22.01.18 and 25.01.18). V = Variety, W = HGC 'Wintergold', J = HGC 'Jesko', RE = 'Royal Emma', SA = 'St. Antonia', SL = 'St. Lucia'. Four plants per variety.

Figures highlighted red are significantly different to all other varieties

Figures highlighted blue are significantly different to varieties marked with an \*

Once the plants had been placed in the shelf life room, the colour change of the petals from white to green was fairly rapid, for all varieties (**Figure 5** and **Appendix 1**). 'Royal Emma' flower buds took approximately seven days to open out into a full flower, the longest of all the varieties. The remaining four varieties had all progressed from a closed bud, to full flower, within four days.

All varieties produced flowers which were very clear white in colour, with no signs of green, although 'Royal Emma' is naturally more cream than white. HGC 'Jesko' was the first variety to start turning green, this was noticeable on 11.01.18, seven days after the flower bud was first tagged. HGC 'Wintergold' was also turning slightly green on this assessment date. All other varieties were still white or cream.

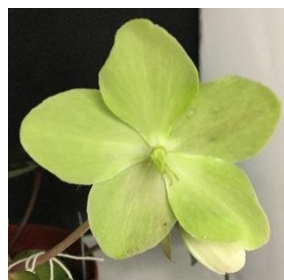
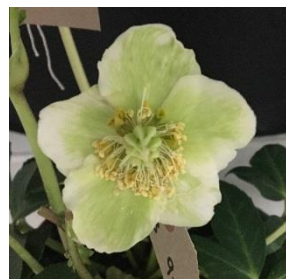
Four days later, on 15.01.18, the first set of flowers had turned green in all varieties. The petals of HGC 'Jesko' and HGC 'Wintergold' were slightly more mottled than the other varieties, with some white remaining around the edge of the HGC 'Jesko' petals. These white edges remained on the HGC 'Jesko' petals until the end of the shelf life period. The petals of HGC 'Wintergold' and HGC 'Jesko' were also starting to droop, and deteriorate towards the end of the shelf life period, whereas the petals in 'Royal Emma', 'St. Antonia' and 'St. Lucia' remained firm and of a better quality.

'Royal Emma' was the most floriferous variety during the shelf life period, with plenty of new buds coming through, as well as open flowers, but it was the last to come into flower. Earlier on in the trial, when the plants were still outside, HGC 'Wintergold' and HGC 'Jesko' had flowered earlier than the other varieties, and these plants were very floriferous, and the flowers remained white for a long time. However, once in the shelf life room, the flowers on these two varieties changed colour very quickly, and because they had flowered earlier in the season, there were no new buds coming through. 'St. Lucia' and 'St. Antonia' performed reasonably well in shelf life, maintaining the white flower colour slightly longer than HGC 'Wintergold' and HGC 'Jesko', and also producing flowers that pointed upwards when they first opened. However, these varieties also struggled to produce more buds towards the end of the shelf life period.



**Figure 5.** Flower development and colour change from the start of the shelf life test (04.01.18) until week 4 (25.01.18) – continued overleaf





## Discussion

- The first shelf life assessment highlighted the earlier flowering varieties which may be more suited to an earlier marketing period. Their propensity to flower during this period no doubt reduced their performance in the second shelf life assessment.
- HGC 'Jesko' and HGC 'Wintergold' started flowering early in the season, so by the start of the shelf life test, they had more flowers and fewer flower buds. Open flowers were also starting to age, which makes a relative comparison of performance in the second shelf life assessment with later flowering varieties difficult. The quality of these plants at the end of the shelf life test in week 4 was poor, with yellowing to the lower leaves, and flower stems that were starting to wilt, conditions symptomatic of an earlier flowering period.
- 'Royal Emma' had significantly more buds than all other varieties in week 1, 2018, at the start of the second shelf life test, and continued to produce more buds throughout the shelf life period, however it was the last variety in the trial to come into full flower.
- As a result of its later flowering period, 'Royal Emma' was close to minimum flower/bud specifications in the year it was examined at the point it would have been sold to complement Poinsettia sales.

## Conclusions

- Under the conditions of this trial, HGC 'Wintergold' and HGC 'Jesko' flowered early in the season, and whilst the flowers maintained their colour outside, once the plants were moved into shelf life conditions, they turned green very quickly and the plants themselves began to deteriorate, but this could be a result of the earlier flowering period.
- 'St. Antonia' and 'St. Lucia' produced plenty of white flowers outside, and when these plants moved into shelf life conditions, the colour of the petals lasted for approximately 11 days. New flowers which opened in the shelf life test pointed upwards, although once the flowers started to turn green, they started to face down slightly. The plants did not produce many buds once in the shelf life conditions, and so flowering was not maintained.
- 'Royal Emma' was the last variety to come into flower, and as a result, performed well in the second shelf life test. Although the petals turned green after approximately 11 days, the plants continued to produce lots of buds, and therefore this variety lasted the longest in shelf life.

## Acknowledgements

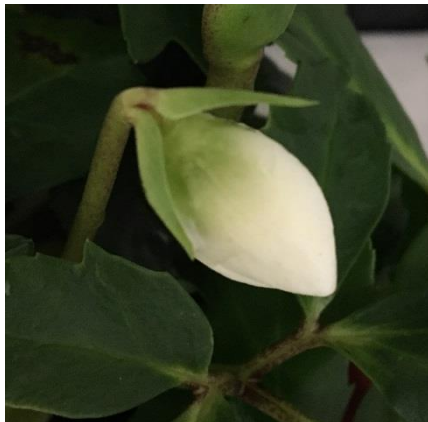
Our thanks to:

- Will Lamb and Jack Olds and the team at Baginton Nurseries for their work and commitment to the project.
- Heuger, Bulrush Horticulture and Pöppelmann Plastics UK Ltd for the provision of plants and other materials.
- The Scientific Support team at ADAS.
- The Management Group for their steering of the project.

## Appendix 1

### Appendix 1.1 Flower development for each variety throughout the shelf life test

*HGC 'Wintergold'*



04.01.18



08.01.18



11.01.18



15.01.18



19.01.18



22.01.18



25.01.18



*HGC 'Jesko'*



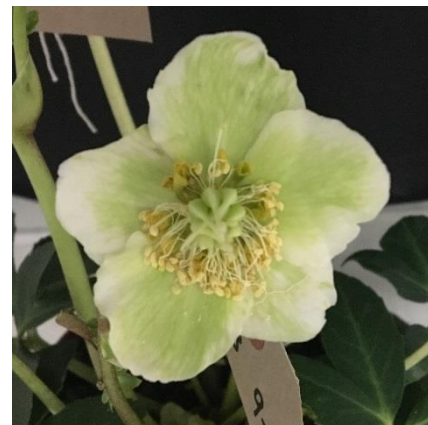
04.01.18



08.01.18



11.01.18



15.01.18



19.01.18



22.01.18



25.01.18

*'Royal Emma'*



04.01.18



08.01.18



11.01.18



15.01.18



19.01.18



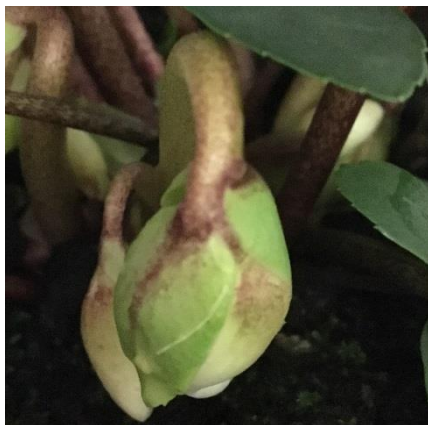
22.01.18



25.01.18



*'St. Antonia'*



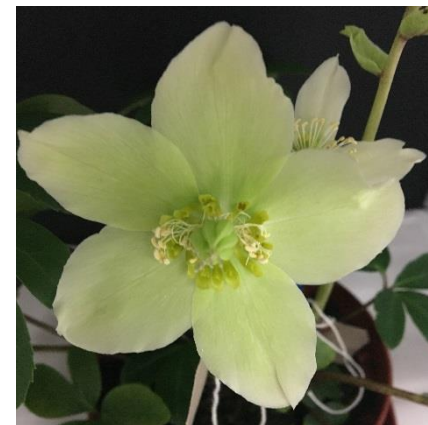
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15.01.18



19.01.18



22.01.18



25.01.18

*'St. Lucia'*



04.01.18



08.01.18



11.01.18



15.01.18



19.01.18



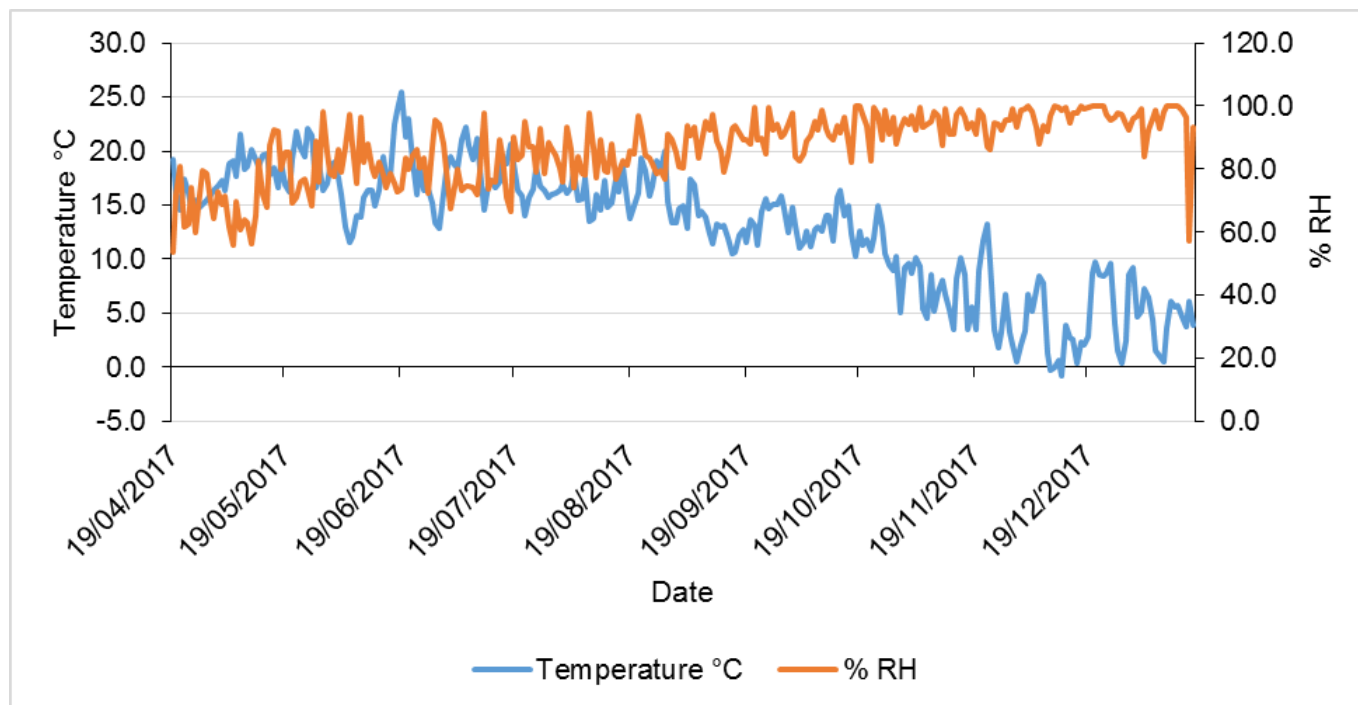
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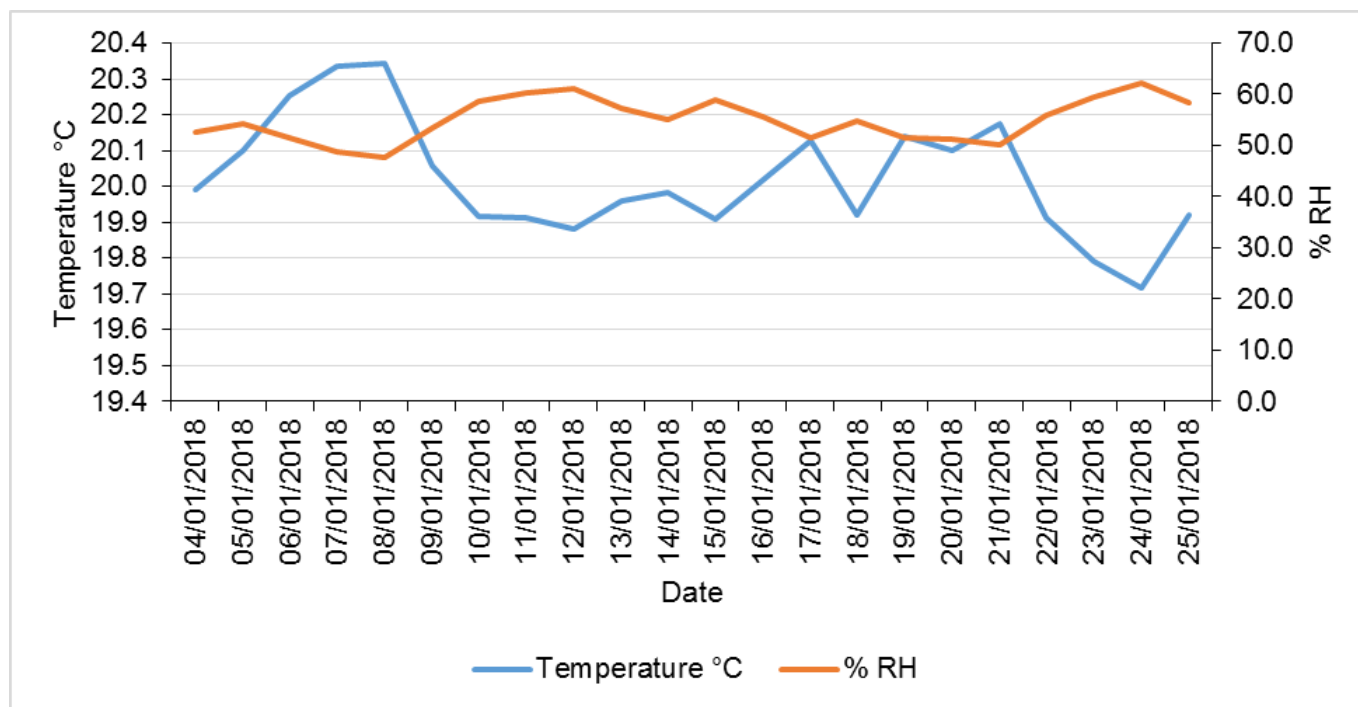
25.01.18

## Appendix 2

### Appendix 2.1. Temperature and humidity throughout the Hellebore trial



**Figure i.** Outdoor temperature and relative humidity throughout the trial, 24-hour average



**Figure ii.** Shelf life room temperature and relative humidity throughout the shelf life period, 24-hour average