Project Title	Collaborative research programme in partnership with Saxon State Institute for Agriculture, Pillnitz, Germany for the development of 'new' ornamental plants for early season sales.
Project number:	PC 247
Project leader:	Andrew Fuller, formerly ADAS.
Report:	Final report, February 2007
Previous report	Not applicable
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Project coordinator:	Steering group - Steve Carter, Farplants; Kevin Campbell, Allensmore Nurseries,; Mike Opperman, Opperman Plants; Mark Huey, STC; Neil Bragg, Bulrush and Steve Adams, HRI Warwick.
Date project commenced:	1st September 2005
Date completion due:	30th July 2006
Key words:	New pot plants, perennial, forcing, supplementary lighting, photoperiodic lighting, vernalisation, early season, sales

for inaccuracy or liability for loss, damage or injury from the application of any concept or procedure discussed.

The results and conclusions in this report are based on a series of experiments conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

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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Headline

Four of 21 perennial / bi-annual species tested were found to be suitable for UK production as pot plants for early spring sales in Feb/March. This provides the potential for additional income for growers between the end of the UK poinsettia season and the start of the main spring bedding plant season. Supplementary lighting is essential to ensure good plant quality and achieve flowering to schedule. Future work will refine the requirements for an additional five species.

Background and expected deliverables

A visit was made to the research station in Germany by representatives of the British Bedding and Pot Plant Association in 2005 to establish the current programme of work on the scheduling of 'perennials' as early season pot plants. The station at Pillnitz, Saxony, amongst others in Germany, has conducted a series of trials over the last 2-3 years and examined over 300 varieties of perennials and bi-annuals for suitability.

Perennial and bi-annual plants exist in a considerably wide spectrum of flower colours and shapes. All species have their own special 'biological rhythm'. Some species loose their leaves during winter, whilst other species retain them. Other species need to grow to a defined size or 'adult stage' to become able to induce flowers. Many species need a signal or a complex of signals for the initiation of the flowering process. These signals are not known for every species in detail as yet, but the length of vernalisation (cold requirement), light levels, day length and growing on temperature are strong influencing factors that control flowering in most species.

Suitable pot grown perennial / bi-annual subjects for early spring sales have to possess the following characteristics:

- the period of flowering should be definite,
- it should be possible to force flowering before the natural flowering period,
- there should be a good level of flowering in the first year,
- the habit of the plant should be compact,
- the flowers should last long and the plant should have a long shelf life in heated rooms,
- the species should be homogenous.

The objectives of the project were:

- to enlarge the number of pot grown/bi-annual species and varieties available to growers for early spring sales,
- to provide specific advice for the cultivation of promising species / varieties,
- to co-ordinate the scheduling and succession of plants after poinsettias and before pack bedding and pot bedding / patio plants,
- to consider the consumers interests especially shelf life / garden performance.

In addition to the objectives listed above which related specifically to the HDC funded project (PC 247) and will be referred to as the 'UK trial' at Pillnitz, Pillnitz research station was also able to link into other research work evaluating the use of different fertiliser strategies and work examining a further range of species from Kieft seeds. This work is also included in the final report.

Summary of the project and main conclusions

It is important to recognise the climatic variation that exists between conditions in the UK and that at Pillnitz, Germany when interpreting the results of this trial.

21 perennial / bi-annual species were grown for the UK trial at Pillnitz. W J Findon and Son supplied the plants in two different plug sizes (240 trays cv. 2cm plug and 140 tray cv. 5cm plug) and arranged transportation to Germany in week 41, 2005. This produced plants of different sizes, so a bigger plug was distinctly older than a smaller plug (except the two species *Papaver* and *Lupinus* which had the same sowing week).

The plugs were potted immediately and were grown under higher temperatures (14^{o}C) for 14 days to promote rooting and plant establishment before they entered the cooling phase. After 14 days the plants were either grown in an unheated polythene tunnel or in a cold glasshouse. The plants received 5 weeks of cool conditions prior to forcing. Forcing occurred in three glasshouse compartments with different lighting treatments (supplementary lighting, day length extension and ambient daylight). In each compartment, plants were placed in three replicate plots with 14 plants per plot.

During the forcing period, the three glasshouse compartments were exposed to different amounts of light. In the case of the supplementary lighting treatment, plants received 50% more light up to Valentine's Day and about 40% more light up to the 5th of March compared to the photoperiodic and ambient daylight treatments. The temperature was a little higher in the glasshouse compartment with the supplementary light treatment because of the radiated heat from the lamps.

From the 21 species tested in the UK trial the following were deemed suitable as pot plants for early season sales in February / March:

- *Aquilegia* 'Spring Magic Blue and White'
- *Geum coccineum* 'Cooky'
- *Arenaria montana*
- *Saxifraga* x *arendsii* 'Carpet Purple'

Further efforts are necessary to make the following varieties suitable as pot plants for early season sales, but they offered potential as good 'impact flowering' plants. The application of plant growth regulators, use of larger pots, their use in mixed containers and evaluation of other breeding lines would be important to assess the use of these species further:

- *Delphinum* Cultivars 'Guardian Blue'
- *Digitalis purpurea* 'Camelot Cream'
- *Heuchera purpurea* 'Ruby Bells'
- *Papaver nudicaule* 'Garden Gnome'
- *Scabiosa japonica* var. *alpina* 'Ritz Blue' or 'Diamond Blue'

The comparison between growing plants under polythene (unheated) or under glass (frost protection) during the cool phase appeared to have no effect on any of the parameters recorded in all the species.

Most species were influenced by the lighting treatments. Supplementary lighting had the greatest effect bringing flowering time forward and improving plant marketability and overall quality.

There was an effect of plug size / plant maturity on some species, with larger plugs producing better quality plants at marketing (better plant habit and more flowers per pot).

The following summaries are provided for each species as guidance to growers:

Recommendation for Aquilegia F1 Spring Magic 'Blue and White'
Potting should take place earlier, e.g. in weeks 26 to 30 (9-11cm pot). Outdoor conditions might be better for improved plant habit / compact shape until the first frosts. Storage should take place for about 9 weeks (week 40 to 50) in a cold glasshouse (h: 4°C, v: 6°C). Plants with 10 weeks cooling had more pronounced flower stems and had double the amount of flowers per plant. Plants flowered 3.5 weeks earlier than plants without cooling (9 weeks in glasshouse 14°C).

Recommendation for Geum coccineum 'Cooky'
Start early in week 30 to 35 to get more growth and more flowers. Storage is possible in a cold glasshouse or polythene tunnel. Supplementary and photoperiodic light have the advantage that more plants come into flower over a shorter time and before Valentine's Day, but ambient daylight maybe sufficient for early spring flowering. Until now growth regulators were not used but they could be tested to try and reduce the length of the flowering stems. There is already an ongoing breeding programme trying to reduce the habit with this species.

Recommendation for Arenaria Montana
Arenaria could be a small accessory crop, grown for spring arrangements. The species appeared better suited to cool conditions. Start potting from week 40 into 8 or 9 cm pots and let the plants root in higher temperatures (14°C) for 2 weeks. Keep them in a cold glasshouse for storage and start forcing in week 50. *Arenaria* responds to the level of temperature provided so, if possible, expose the plants to higher temperatures for a couple of days. With ambient daylight, the plants will flower from week 9 to 10.

Recommendation for Saxifraga x arendsii
In former trials the variety 'Peter Pan' grown from cuttings was more successful because it stayed compact and the flower stems did not stretch above the leaves. Start potting week 31 and grow them outdoors or in a cold glasshouse. With plugs grown from seed, potting can be carried out in week 35. Pot sizes from 9 to 12 cm can be used. Storage can take place in a polythene tunnel or cold glasshouse from week 40 to week 50. Start forcing in week 50. Marketing in February is possible with supplementary light or photoperiodic light and with forcing temperatures between 10°C to 12 °C. To avoid soft growth it is possible to grow the plants at 4°C with supplementary light and force plants into flower in week 7 to 8. Plants that were grown at 4°C and with ambient daylight flowered in week 11 to 12. With ambient daylight and 10 °C flowering occurred in week 8 to 10.

Recommendation for Papaver nudicaule 'Garden Gnome'
Potting should be around 5 weeks earlier (week 35, into a 10 cm pot) to get more growth and more flowers. As a result of the short shelf-life of the flowers (7 days), there needs to be enough buds present on the plant at the start of shelf-life. More buds were present when supplementary light was applied in the forcing period. Storage in a cold glasshouse is better for the development of leaves than in an unheated polythene tunnel. The tall flower stem restricts the number of shelves per trolley. It could be that the breeders have an alternative compact species with the same bright flower colour range.

Recommendation for Scabiosa japonica var. alpina 'Ritz Blue' and 'Blue Diamond'
Start potting earlier (week 35) to develop more leaves and more flowers. The pot size should be 10cm or 11 cm. The cold storage period should be from week 40 to week 50 in a polythene tunnel or cold glasshouse (h: 4°C, v: 6°C). Supplementary lighting is necessary for successful cropping in weeks 9 to 10.

Financial benefits

The aim of the project was to screen plant products that could be grown for early spring sales as alternatives to the traditional pansy and primrose crops. 'New' plants with different flower colours and types can stimulate the market and generate higher price margins compared to traditional crops. Much, as always, depends upon the marketing outlet and perceived value of the customer, but the objective was to market the crop as a premium high value product.

The project aimed to fit the production of these 'new' crops between existing cropping schedules used by growers (after poinsettias and before main bedding plants). The project identified that plants could be grown and forced during this period effectively, creating a potential new crop and income for growers. However, it was found that to achieve accurate scheduling and plant quality the use of supplementary lighting was necessary. It is questionable at this stage whether the installation of a new lighting rig could be financially justified. However, where lighting currently exists within a facility it could be used.

The low forcing temperatures (cv. 10ºC) are suited for glasshouse production and there appears scope to investigate lower forcing temperatures combined with supplementary lighting – additional lighting costs being offset by lower heating requirements.

Action points for growers

- Consider trialling production of early season plants in 9-11cm pots. The following varieties appeared suitable for production under cool glass; *Aquilegia* 'Spring Magic Blue and White', *Geum coccineum* 'Cooky', *Arenaria Montana* and *Saxifraga* x *arendsii* 'Carpet Purple'.

- Pot plants between week 30-35 from plugs to ensure plants establish prior to the start of the cooling phase in week 40.

- Minimal frost protection is required during the cooling phase (polythene tunnels would suffice) and produced plants better than those grown under glass in the majority of cases.

- Plants can be brought inside under glass for forcing after poinsettias (week 50 / 52) and grown on at a minimum of 10ºC.

- The use of supplementary lighting is essential to accurately schedule the crop and produce better plant quality at marketing.

Science Section

Introduction

The main objective of this research project is to assist growers in the U.K and Germany to improve their economic returns and develop the market for early season (in February and March) sales of pot plants.

The standard products offered during this marketing time like primrose and pansy are produced en-mass with constant pressure to reduce prices. Many nurseries cannot compete with the high volume producers of these products and still generate a satisfactory economic return. Although some growers can trial alternative products, large scale testing can be expensive for individual nurseries themselves to undertake.

This project aimed to identify new species and varieties of plants (both perennials and bi-annuals) that could be used successfully by growers to exploit the sales opportunity in February-March. These would be produced after the main poinsettia season and before the start of the bedding / patio plant season. The work included development of cultural information and guidance for growers on the successful production and scheduling of crops, and included tests on the performance of each product in shelf-life.

The project came about as a result of a visit to the Pillnitz research station in Germany by representatives of the British Bedding and Pot Plant Association in 2005 to establish the current programme of work on the scheduling of 'perennials' as early season pot plants. The station at Pillnitz, Saxony, amongst others in Germany, has conducted a series of trials over the last 2-3 years and tested over 300 varieties of perennials and bi-annuals for their suitability. The opportunity existed to develop a collaborative project with this research station supporting both the research project at STC (HDC PC 246) in the UK and establishing the principle of cross-European research work. The knowledge of other research stations in Germany in this area is known in detail by the Pillnitz research team, whilst the UK produces a very large assortment of perennials and has special knowledge about their production, which is not readily available in Saxony.

Perennial and bi-annual plants exist in a considerably wide spectrum of flower colours and shapes. All species have their own special 'biological rhythm'. Some species lose their leaves during winter, whilst other species retain them. Other species need to grow to a defined size or 'adult stage' to become able to induce flowers. Many species need a signal or a complex of signals for the initiation of the flowering process. These signals are not known for every species in detail as yet, but the length of vernalisation (cold requirement), light levels, day length and growing on temperature are strong influencing factors that control flowering in most species.

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Materials and methods

1. UK Trial

21 species of perennials were grown for the UK trial. All the species were grown from seeds by W J Findon and Son in the UK and shipped to Germany in week 41, 2005. The plants were supplied in two different plug sizes (240 trays cv.2cm plug and 140 tray cv. 5cm plug). This produced plants of different sizes, so a bigger plug was distinctly older than a smaller plug (except for the species Papaver and Lupinus which had the same sowing week). All the plants were potted up at Pillnitz into suitable pot sizes (8cm, 10cm or 12cm diameter pot). The list of the 21 plants species, plug size and final pot size is presented in Table 1.

Table1. Species, plug and pot sizes in the UK trial

Species number	Species	Plug size in cm	Pot size in cm
1	*Aquilegia flabellate* 'F1 Spring Magic Blue and White'	2	8
1	*Aquilegia flabellate* 'F1 Spring Magic Blue and White'	5	10
2	Delphinium variety 'Guardian Blue'	2	10
3	*Digitalis purpurea* 'Camelot Cream'	2	10
3	*Digitalis purpurea* 'Camelot Cream'	5	12
4	*Papaver nudicaule* 'Garden Gnome'	2	8
4	*Papaver nudicaule* 'Garden Gnome'	5	10
5	*Lupinus nanus* 'Gallery Blue'	2	10
5	*Lupinus nanus* 'Gallery Blue'	5	12
6	*Lobelia speciosa* 'F1 Fan Scarlet'	2	10
6	*Lobelia speciosa* 'F1 Fan Scarlet'	5	12
7	*Scabiosa japonica* var. *alpina* 'Ritz Blue'	2	10
7	*Scabiosa japonica* var. *alpina* 'Ritz Blue'	5	12
8	*Echinacea pupurea* 'Primadonna Deep Rose'	5	12
9	*Geranium sanguineum* 'Light Pink'	2	8
9	*Geranium sanguineum* 'Light Pink'	5	10
10	*Dianthus deltoides* 'Confetti Carmine Rose'	5	10
11	*Penstemon heterophyllus* 'Electric Blue'	5	12
12	*Geum coccineum* 'Cooky'	5	10
13	*Heuchera sanguinea* 'Ruby Bells'	5	12
14	*Leucanthemum* x *superbum* 'Crazy Daisy'	5	12
15	*Penstemon digitalis* 'Mystica'	5	12
16	*Delphinium grandiflora* 'Summer Stars Blue'	5	12
17	*Coreopsis grandiflora* 'Baby Sun'	5	12
18	*Arenaria montana*	2	8
18	*Arenaria montana*	5	10
19	*Chaenorhinum organifolium* 'Blue'	2	8
19	*Chaenorhinum organifolium* 'Blue'	5	10
20	*Scabiosa japonica* var. *alpina* 'Blue Diamonds'	2	10
20	*Scabiosa japonica* var. *alpina* 'Blue Diamonds'	5	12
21	*Saxifraga* x *arendsii* 'Carpet Purple'	5	10

After potting the plugs were grown at higher temperatures for 14 days to promote rooting and plant establishment before they entered the cooling phase. After 14 days plants were either grown in an unheated polythene tunnel or in a cold glasshouse. The plants received 5 weeks of vernalisation before forcing (this period was shorter than planned due to transportation difficulties). Forcing started in three glasshouse compartments with different lighting treatments. In each compartment plants were placed in three replicate plots with 14 plants per plot. The production and treatment list is given in Table 2.

Table 2. Production and treatment diary for plants in UK trial at Pillnitz

Week number	Date	Location	Treatment
42	20 and 21 Oct 05	Glasshouse (H 13.4)	Potting plants into substrate: Stender D400 Geotorf for 8cm pots , Stender SO Mix M2 with xylit for 10 and 12cm pots. Temperatures – heating 14ºC, venting 16ºC to encourage rooting.
43	28 Oct 05	Glasshouse (H 13.4)	0.02% Discus + 0.01% Karate Zeon + 0.1% Wuxal Amino
43	28 Oct 05	Glasshouse (H 13.4)	Cold misting with Confidor WG 70 + Karate Zeon.
44	4 Nov 05	Glasshouse (H 13.4)	0.035% Confidor WG 70 + 0.02% Discus and 0.015% Break Thru
45	From 4 Nov 05	Glasshouse (H 13.4)	Temperatures heating 2ºC and venting 4ºC
45	7 and 8 Nov 05	Polythene tunnel and glasshouse (H 13.4)	Moving plants into unheated polythene tunnel or cold glasshouse for vernalisation period. In the glasshouse - heating 2ºC and venting 4ºC, in the polythene tunnel venting started at 8-10ºC.
46	18 Nov 05	Polythene tunnel and glasshouse (H 13.4)	0.2% Dithane Ultra + 0.035% Confidor WG 70 + 0.25% Wuxal Amino.
47	24 Nov 05	Polythene tunnel and glasshouse (H 13.4)	Steinernema feltiae watered in.
49	5 Dec 05	Polythene tunnel and glasshouses (H 12.2 + H 12.3)	0.2% Polyram WG
49	5 Dec 05	Glasshouse compartments H13.4 to H12.3+ H 12.2)	Plants transferred to the glasshouse compartments, temperatures still heating 2ºC and venting 4ºC.
50	15 and 16 Dec 05	Glasshouse compartments (H 12.1, 12.2 + 12.3)	Plants placed into different treatments.
50	17 and 18 Dec 05	Glasshouse compartments (H12.1, 12.2 + 12.3)	From Friday to Monday (approx 60 hours) plants pushed with higher temperatures heating 20ºC, venting 23ºC.
51	19 Dec 05	All glasshouse compartments	Back to lower temperatures heating 10ºC and venting 12ºC and light treatments begin. Supplementary lighting – 3000 lux, 20 hours, 4.00-24.00 = 0.13 mol/m^2; 8.13 W/m^2 PAR. (H 12.1) Photoperiodic lighting – 100 lux / m^2, 20 hours, 4.00-24.00 = 0.0044 mol/m^2; 0.275 W/m^2 PAR. (H 12.2) Ambient day light (from sunset to sunrise the plants were covered to protect them from light spillage from other treatments). (H 12.3)
51	22 Dec 05	All glasshouse compartments	0.17% Perfekthion + 0.1% Rovral.
1	2 Jan 06	All glasshouse compartments	0.17% Perfekthion + 0.1% Rovral + 0.1% Ortiva + 0.015% Break Thru
1	2 Jan 06	All glasshouse compartments	Temperatures increased to heating 12ºC and venting 15ºC
1	4 .Jan 06	All glasshouse	Old foliage removed from plants

		compartments	
5	2 Feb 06	All glasshouse compartments	Fertiliser applied – 0.2% Flory 1 rot (20-5-10-2 micros) all 10 and 12cm pots.

Key to terminology:
Discus – *Kresoxim-methyl* 500g/l Karate Zeon – *Lambda-cyhalthrin* - Confidor – *Imidacloprid*
Break Thru – Silicon polyether Wuxal Amino – 700g/l amino acid (9% nitrogen)
Polyram WG – Metiram Perfekthion – *Dimethoate* 400g/l Rovral – *Iprodione*
Ortiva – *Azoxystrobin* 250g/l Dithane Ultra – *Mancozeb*
Note: these are specific German approvals (not UK)

2. Fertiliser Trial

The trial included a number of plant species that had already proven successful in previous trials; *Ajuga*, *Lithodora* and *Androsace*. Two new varieties of *Ajuga* were used; *Ajuga* 'Rosea' and *Ajuga* 'Variegata'. Both the *Ajuga* and *Lithodora* were delivered by Agrexco, Israel as rooted cuttings in plugs. The *Androsace* was grown from seed at the Pillnitz research station. The objective of the work was to examine how the various species reacted to different amounts of base fertilizer in the growing medium. The basis for this work was the hypothesis that plants kept outside without protection had an increased risk of nutrient leaching during rainfall, coupled with increased nutrient demand during the forcing period under protection. The trial aimed to assess the effect of different rates of base fertiliser on plant growth and determine if damage can result from too much fertiliser. The list of species grown and relevant pot size is shown in Table 3.

Table 3. Species and pot sizes in the fertilizer trial

Species number	Species	Pot size in cm
1	*Ajuga reptans* 'Variegata'	9
2	*Ajuga reptans* 'Rosea'	9
3	*Ajuga reptans* 'Mini Mahagoni'	9
4	*Androsace septentrionalis* 'Star Dust'	9
5	*Lithodora diffuas* 'Heavenly Blue' agrexco	11
6	*Lithodora diffusa* 'Heavenly Blue' LfL	11

The various rates of base fertiliser applied per pot at potting are summarised below:

1. approx. 200 mg N per plant (1,5 g Manna Cote Mini 4 M 19-6-11)
2. approx. 700 mg N per plant (3,5 g Manna Cote Mini 4 M 19-6-11)
3. approx. 1200 mg N per plant (6 g Manna Cote Mini 4 M 19-6-11)

Forcing was started in three glasshouse compartments used for the different light treatments in the UK trial. In each compartment the plants were placed in three replications of either 12 plants (Ajuga and Androsace) or 16 plants (Lithodora). The production and treatment list is given in Table 4.

Table 4. Production and treatment diary for the plants in the fertiliser trial

Week number	Date	Location	Treatment
27	5 July 05	Glasshouse (H 14.1)	Propagation of Lithodora from own stock (small polythene tunnel for rooting)
28	13 July 05	Glasshouse (H 14.1)	Sticking cuttings of Ajuga in QP 40 trays, substrate: Stender D400 with Geotorf and cuttings of Lithodora from Agrexco in QP 20 trays in turf-sand mixture, first watering with Previcur N 0.15% (small polythene tunnel until watering).
29	18 July 05	Glasshouse (H 14.7 + H 14.8)	0.015% Discus + 0.1% Tamaron + 0.3% Wuxal Amino all Ajuga and Lithodora.
31	2 Aug 05	Glasshouse (H 11.2)	Androsace seeds sown.
33	18 Aug 05	Outdoor	Potting Ajuga and Androsace seedlings in substrate: Stender D 400 with Geotorf and fertiliser Manna Cote Mini 4M 19-6-11 in three amounts – 1.5g: 3.5g and 6g per pot. Androsace covered with fleece for 5 days because of weak plants.
35	26 Aug 05	Outdoor	Potting Lithodora in substrate: Hansa Torf Stender D 400 with Geotorf and three different amounts of fertiliser (as above).

Week number	Date	Location	Treatment
40	6 and 7 Oct 05	Glasshouse (H 14.7 + 14.8) and polythene tunnel	Plants moved into unheated polythene tunnel or cold glasshouse for storage, heating 2ºC and venting 4ºC in glasshouse, vents in tunnel open from 8-10ºC.
41	11 Oct 05	Glasshouse (H 14.7 + 14.8) and polythene tunnel	0.2% Dithane Ultra + 0.02% Discus + 0.2% Wuxal Amino
42		Glasshouse (H 14.7 + 14.8) and polythene tunnel	Spacing and trimming of Ajuga reptans 'Rosea' and Ajuga reptans 'Mini Mahagoni'
43		Glasshouse (H 14.7 + 14.8) and polythene tunnel	0.02% Discus + 0.01% Karate Zeon + 0.1% Wuxal Amino.
44	4 Nov 05	Glasshouse (H 14.7 + 14.8) and polythene tunnel	0.035% Confidor WG 70 + 0.02% Discus + Break Thru.
46	18 Nov 05	Glasshouse (H 14.7 + 14.8) and polythene tunnel	0.2% Dithane Ultra + 0.035% Confidor WG 70 + 0.25% Wuxal Amino
47	24 Nov 05	Glasshouse (H 14.7 + 14.8) and polythene tunnel	Plants watered with *Steinernema feltiae*
49	5 Dec 05	Glasshouse (H 14.7 + 14.8) and polythene tunnel	0.2% Polyram WG
50	15 and 16 Dec 05	Glasshouse (H 12.1)	Plants placed into different treatments
50	17 and 18 Dec 05	Glasshouse (H 12.1)	From Monday to Friday (approx 60 hours) plants pushed with high temperatures heating 20ºC, venting 23ºC
51	19 Dec 05	All glasshouse compartments	Temperatures reduced to heating 10ºC, venting 12ºC and lighting treatments commence. Supplementary lighting – 3000 lux, 20 hours, 4.00-24.00 = 0.13 mol/m^2; 8.13 W/m^2 PAR. (H 12.1) Photoperiodic lighting – 100 lux / m^2, 20 hours, 4.00-24.00 = 0.0044 mol/m^2; 0.275 W/m^2 PAR. (H 12.2) Ambient day light (from sunset to sunrise the plants were covered to protect them from light spillage from other treatments). (H 12.3)
51	22 Dec 05	Glasshouse compartment (H 2.1)	0.17% Perfekthion + 0.1% Rovral.
1		Glasshouse compartment (H 12.1)	0.17% Perfekthion + 0.1% Rovral + 0.1% Ortiva + 0.015% Break Thru.
1	2 Jan 06	All glasshouse compartments	Temperatures raised to heating 12ºC and venting 15ºC.
2	4 Jan 06	All glasshouse compartments	*Ajuga* and *Androsace* spaced and *Ajuga* cleaned.
3	19 Jan 06	All glasshouse compartments	*Lithodora* spaced.

Key to terminology;

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Dithane Ultra – *Mancozeb* Tamaron - *methamidophos*

Note: these are specific German approvals (not UK)

3. Additional Species by Kieft Seeds Trial

The trial contained 28 species that were grown from seed at Pillnitz research station during 2005. The objective of this trial was simply to act as a 'screen' to identify potential new interesting plant species that could be adapted to fit into a production programme for early season sales. The list of species grown is shown in Table 5.

Table 5. Species and pot sizes in the Kieft Seeds trial

Species number	Species	Pot size in cm
1	*Agastache astromontana* 'Pink Pop'	11
2	*Anacyclus depressus* 'Spring Carpet'	11
3	*Aquilegia vulgaris* 'Clementine Blue'	11
4	*Aquilegia vulgaris* 'Clementine Dark Purple'	11
5	*Aquilegia vulgaris* 'Clementine Red'	11
6	*Aquilegia vulgaris* 'Clementine Rose'	11
7	*Aquilegia vulgaris* 'Clementine Salmon Rose'	11
8	*Aquilegia vulgaris* 'Clementine White'	11
9	*Barbarea rupicola* 'Sunnyola'	11
10	*Calceolaria biflora* 'Goldcap'	11
11	*Chaenorhinum organifolium* 'Summer Skies'	11
12	*Chiastophyllum oppositifolium* 'Solar Yellow'	11
13	*Digitalis grandiflora* 'Dwarf Carillon'	11
14	*Erigeron karvinskianus* 'Stallone'	11
15	*Erysimum perovskianum* 'Goldrush'	11
16	*Mimulus x hybridus* 'Bounty Orange'	11
17	*Mimulus x hybridus* 'Bounty Red'	11
18	*Mimulus x hybridus* 'Bounty Rose'	11
19	*Mimulus x hybridus* 'Bounty Yellow'	11
20	*Nepeta nervosa* 'Pink Cat'	11
21	*Primula acaulis* 'F1 Exp. Heritage Light Yellow'	11
22	*Primula acaulis* 'F1 Exp. Hertiage White'	11
23	*Primula acaulis* 'Hertiage Creme F1'	11
24	*Rosea chinensis* 'Angel Wings'	11
25	*Salvia roemeriana* 'Hot Trumpets'	11
26	*Silene maritima* 'Icecups'	11
27	*Sisyrinchium californicum* 'Yellow Stone'	11
28	*Veronica prostrata* 'Nestor'	11

Seeds were sown into open seed trays at Pillnitz research station. The date of germination is given in Appendix 2 whilst cultural detail is given in Table 6. As result of the low germination rates there was only sufficient plants for one forcing treatment, so the supplementary lighting treatment was selected using one replication with 8 plants per plot.

Table 6. Production and treatment diary for the plants in the Kieft Seeds trial

Week	Date	Location	Treatment

number			
32	12 Aug 05	Controlled cold store	Sowing of all species, substrate: Stender VM, first watering with Previcur 0.15%, controlled cold storage at 5ºC.
33	17 Aug 05	Controlled cold store	Controlled storage at 15ºC.
34	22 Aug 05	Glasshouse (H 14.1)	Seedlings moved to glasshouse, heating 16ºC and venting 18ºC.
34-37		Glasshouse (H 14.7)	Potting on seedlings using substrate ED 73 with Optifer.

Week number	Date	Location	Treatment
40		Glasshouse (H 14.7) and outdoor	Plants moved into cold glasshouse (heating 2ºC and venting 4ºC) or outdoor.
41	11 Oct 05	Glasshouse (H 14.7) and outdoor	0.2% Dithane Ultra + 0.02% Discus + 0.2% Wuxal Amino.
43		Glasshouse (H 14.7) and outdoor	0.02% Discus, 0.01% Karate Zeon + 0.1% Wuxal Amino.
44	4 Nov 05	Glasshouse (H 14.7) and outdoor	0.035% Confidor WG 70; 0.02% Discus + 0.015% Break Thru.
46	18 Nov 05	Glasshouse (H 14.7) and outdoor	0.2%Dithane Ultra, 0.035% Confidor WG 70 + 0.25% Wuxal Amino.
47	24 Nov 05	Glasshouse (H 14.7)	Watering with *Steinernema feltiae*
49	5 Dec 05	Glasshouse (H 14.7) and outdoor	0.2% Polyram WG
50	15 and 16 Dec 05	Glasshouse compartments (H 12.1, 12.2 + 12.3)	Plants placed into different treatments
50	17 and 18 Dec 05	All glasshouse compartments	From Monday to Friday (approx 60 hours) plants were pushed with higher temperatures: heating 20ºC and venting 23ºC.
51	19 Dec 05	All glasshouse compartments	Temperatures reduced: heating 10ºC and venting 12ºC and light treatments commenced. Supplementary lighting – 3000 lux, 20 hours, 4.00-24.00 = 0.13 mol/m^2; 8.13 W/m^2 PAR. (H 12.1)
51	22 Dec 05	Glasshouse compartment (H 12.1)	0.17% Perfekthion + 0.1% Rovral.
1		Glasshouse compartment (H 12.1)	0.17% Perfekthion + 0.1% Rovral + 0.1% Ortiva + 0.015% Break Thru.
1	2 Jan 06	Glasshouse compartment (H 12.1)	Temperatures raised: heating 12ºC and venting 15ºC.

Key to terminology;
Discus – *Kresoxim-methyl* 500g/l Karate Zeon – *Lambda-cyhalthrin* Confidor – *Imidacloprid*
Break Thru – Silicon polyether Wuxal Amino – 700g/l amino acid (9% nitrogen)
Polyram WG – *Metiram* Perfekthion – *Dimethoate* 400g/l Rovral – *Iprodione*
Ortiva – *Azoxystrobin* 250g/l Dithane Ultra – *Mancozeb* Tamaron – *methamidophos*

Note: these are specific German approvals (not UK).

In the case of all three trials, the plants were monitored every second or third day during the forcing period. If one plant fulfilled the specific criteria for flowering, the measurements and ratings were carried out. Four plants from each plot were measured wherever possible and the following records were taken:

- Date of flowering
- Height of leaves in cm
- Height of flower in cm
- Plant diameter in cm
- Number of flowers per plant
- Number of buds per plant

- Fresh weight in g
- General value (rating 1….9, 1 = very bad; 5 = middle; 9 = perfect)
- General value per plot (rating 1….9, 1 = very bad; 5 = middle; 9 = perfect)
- Market value per plot (rating 1….9, 1 = very bad; 5 = middle; 9 = perfect)
- Uniformity per plot (rating 1….9, 1 = very bad; 5 = middle; 9 = perfect)

During every period / regime of the trial, the temperature, the air humidity and irradiation levels were recorded by data loggers. Appropriate visual observations on each plant species (e.g. diseases) were documented.

Digital photos were made which show the plant species in different factorial combinations at planting, at the beginning of storage, at the beginning of forcing and at flowering.

The shelf life test was run in a separate room with the following controlled conditions:

- artificial light with 300 – 500 lux daily for 12 hours = 0.022 mol/ m^2; 1.375 W/ m^2 PAR
- temperature 20°C – 22°C
- air humidity 40 % - 60 %

The shelf life, in days, was recorded and notes taken to record the reason for the discarded plant.

The data from UK Pillnitz trial and from the fertiliser trial were analysed with help of the statistic programme SPSS. With the two factor analysis of variance, the significances of the single factors were determined as well as the interactions between the factors. The averages of data were compared by BONFERRONI test (with $\alpha = 0.05$). This test is more accurate than other multiple average tests because of the slightly different numbers of plots in the trial. All data from the trials and the most important results of the analysis by SPSS programme were saved on a DVD which is contained in the annex.

Temperature and light conditions at Pillnitz trials

It is important to recognize the climatic variation that exists between conditions in the UK and those at Pillnitz, Germany. The following data collected during the trial period at Pillnitz can be used to compare with UK growing conditions.

Plants in the UK Pillnitz trial started in glasshouse 13.4. From 7 November 2005 they were transferred to glasshouses 12.3 and 12.3, or to an unheated polythene tunnel. During this cooling phase, the plants in the unheated polythene tunnel received double the amount of days with a temperature below 4°C than in the cold glasshouses.

The plants in the fertiliser trial and additional species trial started their storage on 6 / 7 October 2005. They received a longer period of lower temperatures in total, and more days with a minimum temperature under 4°C in the polythene tunnel than in cold glasshouses.

For all environments, the temperature details are given in Table 7.

Table 7. Temperature conditions at Pillnitz

Location	Sum of temp. from averages per days in °C x days 6 Oct to 16 Dec 05	Sum of temp. from averages per days in °C x days 4 Nov to 16 Dec 05	Days with temp. below 4°C	Days with temp. below 3°C	Days with temp below 0°C
H13.4/12.2	703.9	284.6	15	5	
H13.4/12.2	691.3	272.0	10	5	
H14.7	651.3	289.4	9		
H14.8	628.7	277.2	10	4	
Polythene tunnel	529.3	165.0	45	41	22
Polythene tunnel UK Pillnitz trial (7 Nov – 16 Dec 05)			38	36	22

During the forcing period, the three glasshouse compartments were exposed to different amounts of light. This is illustrated in diagram 1. With supplementary lighting, plants received 50% more light until Valentine's Day and about 40 % more light until the 5 March compared to the photoperiodic ambient daylight treatments. The temperature was a little higher in the glasshouse compartment with supplementary light because of the radiated heat from the lamps.

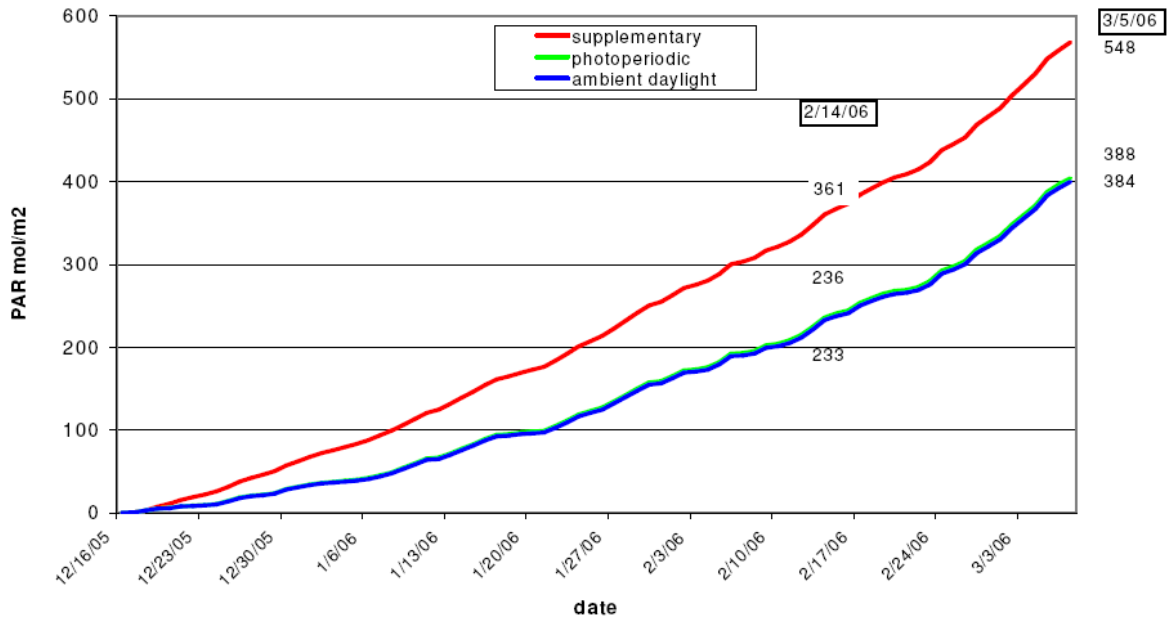


Diagram 1: Development of light summaries in the different light treatments

Sum of temperatures from 16 December to the 5 March:

- Glasshouse 12.1 supplementary light: 997.8 °C x days
- Glasshouse 12.2 photoperiodic light: 981.5 °C x days
- Glasshouse 12.3 ambient daylight: 983.4 °C x days

Results and Discussion

The results have been formulated to present the most promising plant species and those that were deemed suitable for the commercial market.

The main objective of the trial in Pillnitz was to produce marketable plants by Valentine's Day (14 February) or at least to finish the crop before the bedding plant season after which the need for the space in glasshouses rapidly increases.

From the 21 species tested, 13 species came into flower by week 10 in 2006. (The last date of data collection was the 6 March). However, not all the plants within each plot (14 plants) had reached a flowering stage. The exact number is listed in the average table of the species in the DVD annex.

Growing the plants under polythene (unheated) or under glass (frost protected) had little significant effect on any of the parameters recorded in all the species trialled.

Most species were influenced by the lighting treatments. Supplementary lighting had the greatest effect bringing flowering time forward and improving plant marketability and overall quality.

There was an effect of plug size / plant maturity on some species.

All results, shown as bar charts for all species and pot sizes including the influence of lighting on plant parameters, are included in the DVD annex.

The stages of growth and development are collected in a ULEAD PhotoImpact album and in a web browser readable slide show which are saved on the DVD in the annex.

1. UK Pillnitz Trial

Aquilegia F1 'Spring Magic Blue and White' (Ranunculaceae)

This variety with its large single blue and white flowers, produced a very attractive plant (Picture 1) and looked great in mixed arrangements. The single flower did not keep so long under shelf-life conditions. It is important to produce a plant that has a lot of flower buds that are still able to open post marketing. Cooler conditions increase the shelf life of the plant. Not all the plants came into flower even with supplementary lighting. The reason for this is the plants were still juvenile during the autumn and as a result were unable to initiate flower buds. The bigger plants in 10 cm pots gave rise to more flowering plants than plants from the smaller plug size in 8 cm pots. The date of flowering was recorded when there was one bud showing colour per pot.

Picture 1: Week 7; *Aquilegia* 'F1 Spring Magic Blue and White'

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
Plants under supplementary light flowered 2 weeks earlier than plants exposed to photoperiodic light and 3 weeks earlier than plants under ambient daylight. (Diagrams 2 and 3). Plants under the supplementary lighting treatment were ready for selling before Valentine's Day.

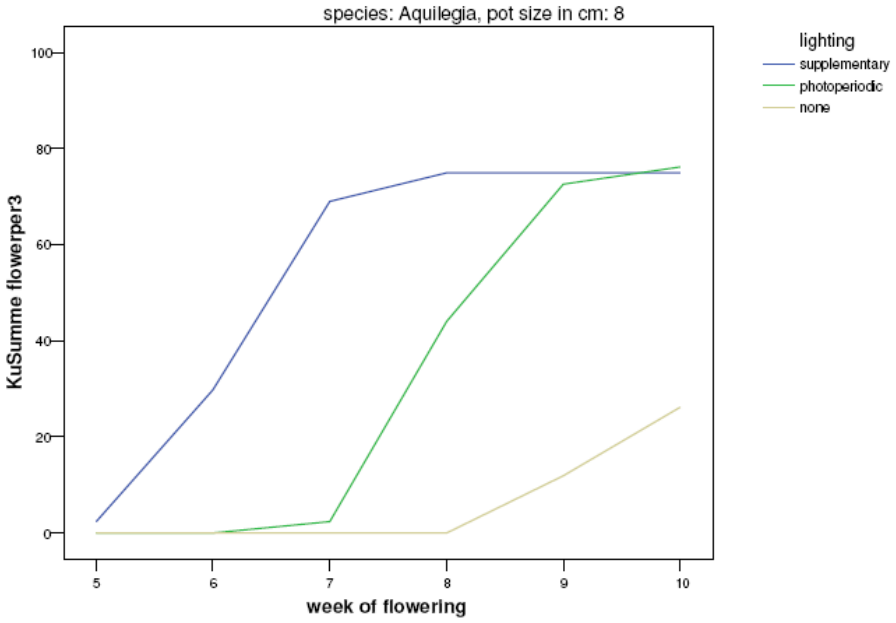


Diagram 2: Percentage of flowering plants relative to the light treatments used in the trial. Aquilegia 'F1 Spring Magic Blue and White'; 8 cm pot size

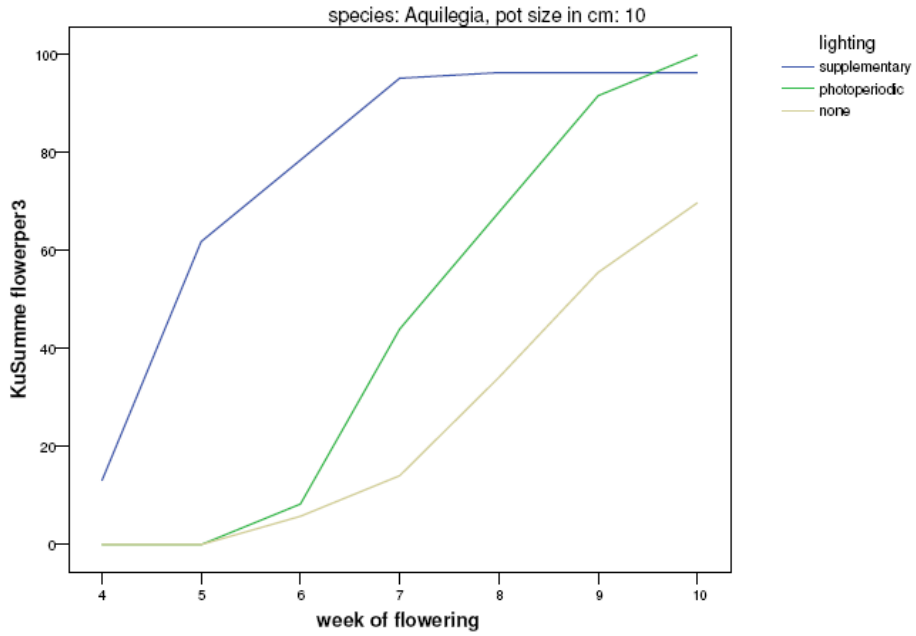


Diagram 3: Percentage of flowering relative to the light treatments used in the trial. Aquilegia 'F1 Spring Magic Blue and White' ; 10 cm pot size

Height of leaves, height of flowers, number of buds, plant diameter and fresh weight
Plants were 5 to 7 cm higher and 8 to 10 cm wider under supplementary and photoperiodic lighting compared to the plants under ambient daylight. The plants in the 10 cm pot were bigger than plants in the 8 cm pot. Flower height under ambient daylight was significantly shorter than under the other light treatments. In fact, the flower buds opened whilst still amongst foliage and there was no stretching of flower stems. The reason for this is believed to be as a result of insufficient vernalisation. The lighting treatments appeared to overcome this lack of vernalisation. Plants with supplementary light had more fresh weight than plants with ambient daylight. Plants from larger plug size initially had on average 1-2 more buds under the supplementary lighting treatment compared to plants from the photoperiodic lighting and ambient daylight.

General value
Plants from the larger plug size received a better score than plants from smaller plug size but overall had a low level of general value. This is because the plants did not have enough time in the autumn growing phase to develop leaves for a good habit. Plants under supplementary light and photoperiodic light received better scores than plants under ambient daylight.

Shelf life test
The shortest time in shelf life was 6 days, while the longest time was 14 days. The duration of shelf life depended on the bud number per plant present at the start of the shelf-life test. The first open flower always dropped off after 6-7 days.

Papaver nudicaule 'Garden Gnome' (Papaveraceae)

The clear vibrant colours of these species were striking, although single plants were not so attractive because of the high flower stem above the leaves. However, in arrangements as a background plant or as a cut flower, the crop could be interesting (Picture 2)

Only the plants under supplementary and photoperiodic lighting came into flower and 100% of plants flowered (except plants in 8 cm pots where the flowering percentage was slightly less). This indicated the requirement of long days for flowering in Papaver (Diagrams 4 and 5). The date of flowering was recorded when there was one bud showing colour per pot.

Picture 2: Week 5; *Papaver nudicaule* 'Garden Gnome', supplementary light; 10 cm pot

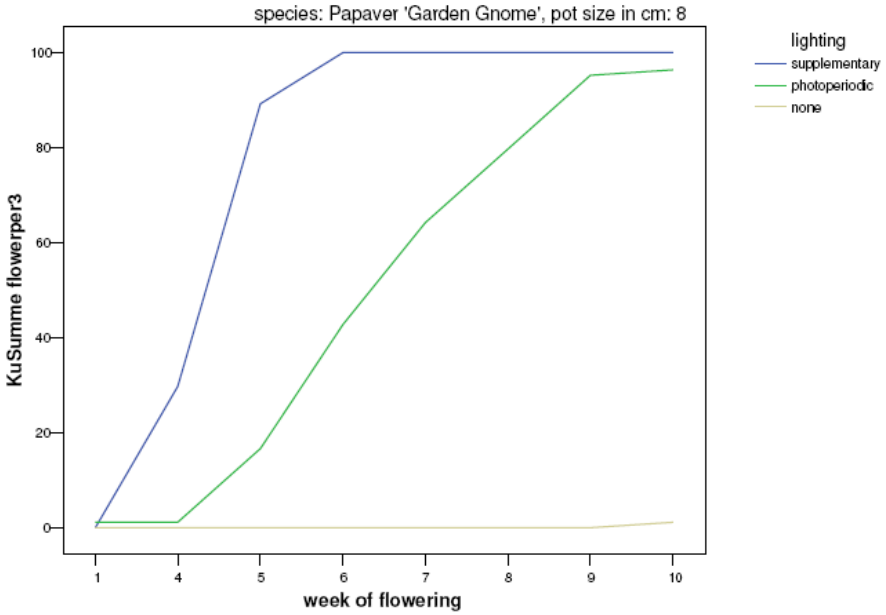


Diagram 4: Percentage of flowering plants relative to the light treatments used in the trial. *Papaver nudicaule* 'Garden Gnome'; 8 cm pot size

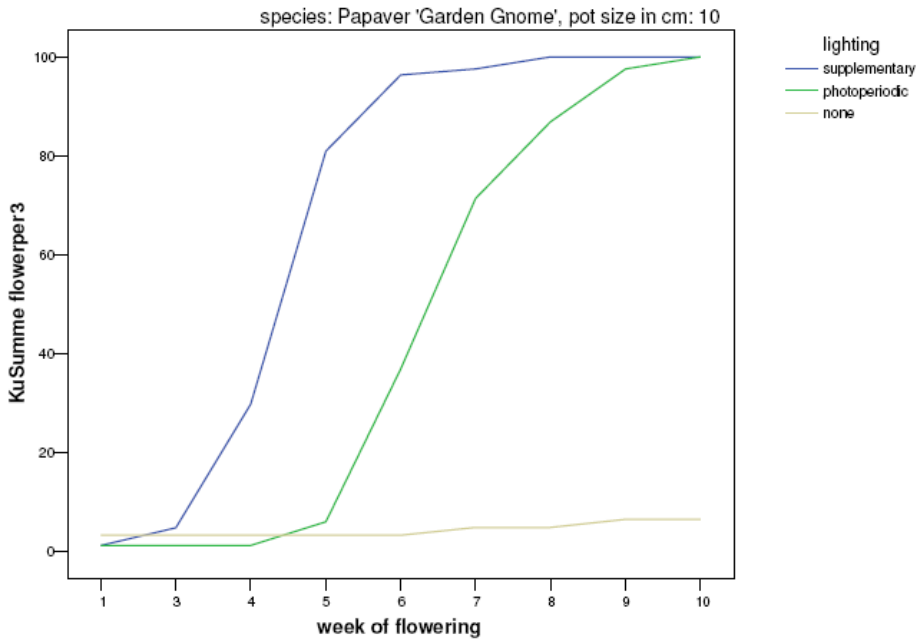


Diagram 5: Percentage of flowering plants relative to the light treatments used in the trial. Papaver nudicaule 'Garden Gnome'; 10 cm pot size

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
Plants under supplementary light were two weeks earlier than plants under photoperiodic light and attained 100% flowering by Valentine's Day. There was no difference in the duration of crops in different pot sizes.

Height of leaves, height of flowers, number of buds, plant diameter and fresh weight
The plants under supplementary and photoperiodic light were taller than plants under ambient daylight. The flowers from plants in 8 cm pots were 4 cm higher under supplementary light those under photoperiodic light. Plants under photoperiodic light were wider than plants under supplementary light, not because of more leaves but because of their soft / leggy growth. Plants in 10cm pots appeared stronger in growth. They had double the fresh weight, were wider, had more leaves and on average 3 to 4 more buds compared to plants in 8 cm pots.

General value
The general value for 8 cm pots was low, between 3 and 4 (out of 9 point scale). There were not enough leaves and the flower stems were too tall. The plants in 10 cm pots grew better. The plants under supplementary light got the better marks (average 6.3) than plants under photoperiodic or ambient daylight.

Shelf life test
The longevity of flowers varied intensely. The shortest time was 7 days, the longest time 20 days. It depended on how many buds were present when plants went into shelf-life. The plants from supplementary light continued to open their buds in comparison to plants from the photoperiodic light which failed to open.

***Geum coccineum* 'Cooky' (Rosaceae)**

This plant had striking orange coloured flowers (Picture 3). The species was both attractive as a single plant and in arrangements. Not all the plants came into flower and across all treatments the flowering time was sporadic. In all three lighting treatments some plants were flowering before Valentine's Day. The plants under supplementary light had a higher

flowering percentage. The date of flowering was recorded when there was one bud showing colour per pot.

Picture 3: Week 3; *Geum coccineum* 'Cooky', supplementary light; 10 cm pot

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
There was no difference in time to flower between the lighting treatments as shown in Diagram 6.

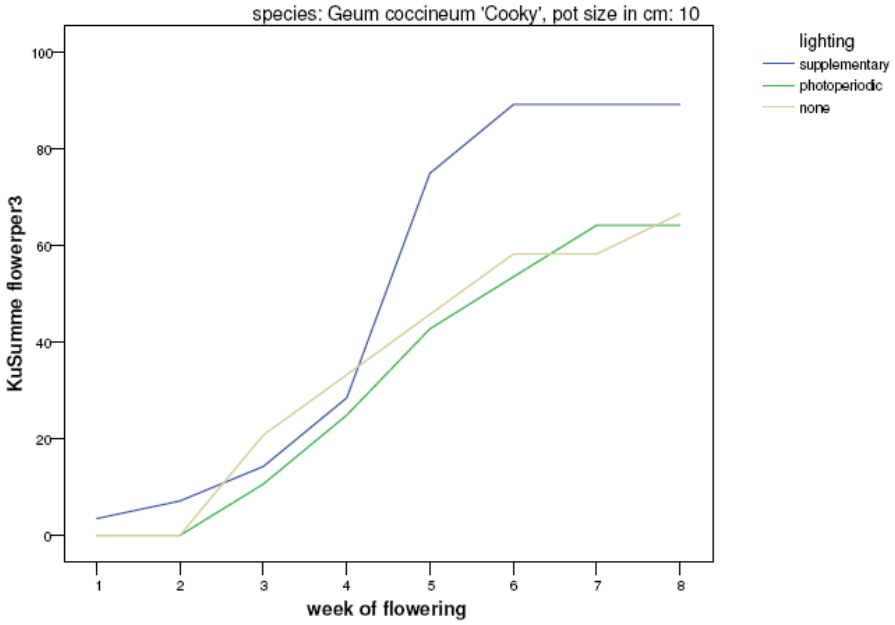


Diagram 6: Percentage of flowering plants relative to the light treatments used in the trial. *Geum coccineum* 'Cooky'

Height of leaves, height of flowers, number of buds, plant diameter and fresh weight
All the above parameters were not influenced by the lighting treatment. The height of leaves under photoperiodic light was slightly greater but not noteworthy.

General value
The general value was average. The flowering stems were sometimes very stretched and there were not enough flowering stems with buds, just the one open flower.

Shelf life test
The shortest time in shelf life was 9 days, while the longest time was 14 days. It depended on the number of buds per plant that were open at the start of the test. The wilted flower looked like brown orange parchment and only after fairly vigorous contact did the petals fall. The leaves still looked attractive.

***Scabiosa japonica* var. *alpina* 'Ritz Blue' and 'Blue Diamond' (Dipsacaceae)**

This species had light violet coloured flowers. Supplementary lighting was necessary to induce flowering prior to week 10. There was a higher percentage of flowering plants from the larger plugs (in 12 cm pots) and under supplementary lighting (Picture 4). The date of flowering was recorded when there was one bud showing colour per pot. There were plants with one flower in week 4 but the shelf life has shown that the amount of light was not enough to open following buds. From week 8 onwards, more plants came into bloom.

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
The average duration of cropping showed no significant difference between the supplementary and the photoperiodic lighting treatments. However, until week 10 a higher percentage of plants were flowering under supplementary light than under photoperiodic lighting. The 'Blue Diamond' had a lower percentage in flower than 'Ritz Blue' until week 10. The plugs from 'Ritz Blue' were already well developed before potting (Diagrams 7, 8, 9 and 10).

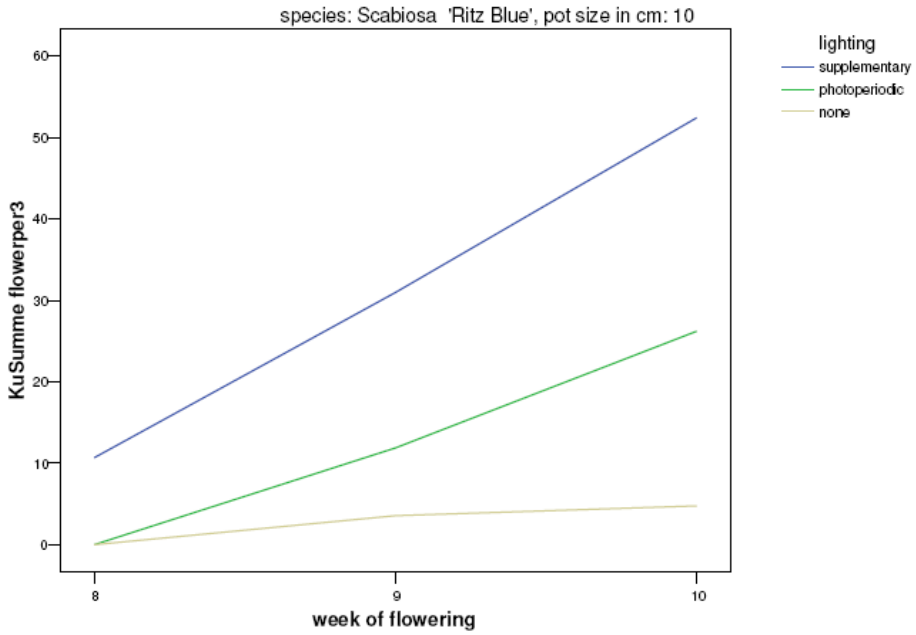


Diagram 7: Percentage of flowering plants relative to the light treatments used in the trial. *Scabiosa japonica* var. *alpina* 'Ritz Blue'; 10 cm pot size

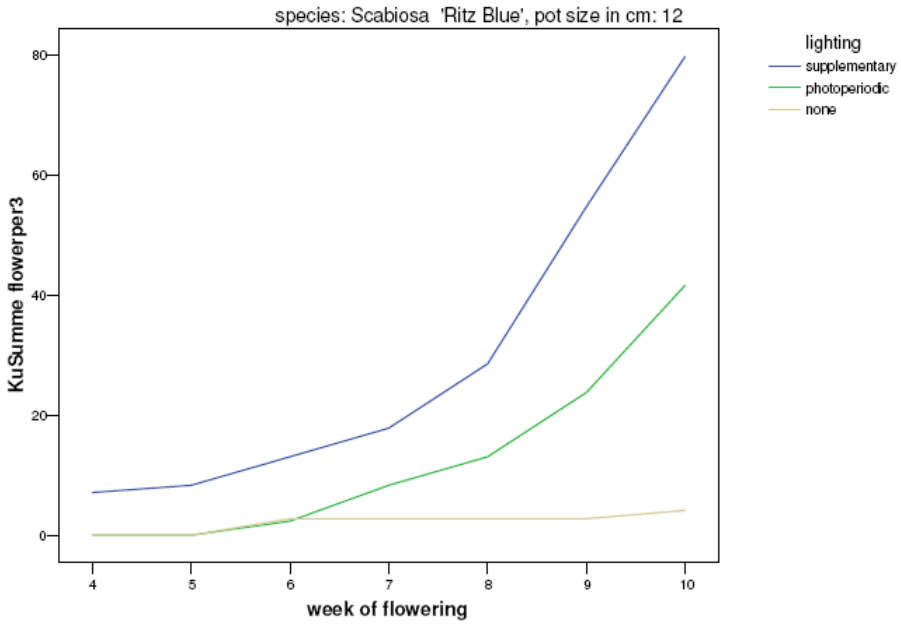


Diagram 8: Percentage of flowering plants relative to the light treatments used in the trial. *Scabiosa japonica* var. *alpina* 'Ritz Blue'; 12 cm pot size

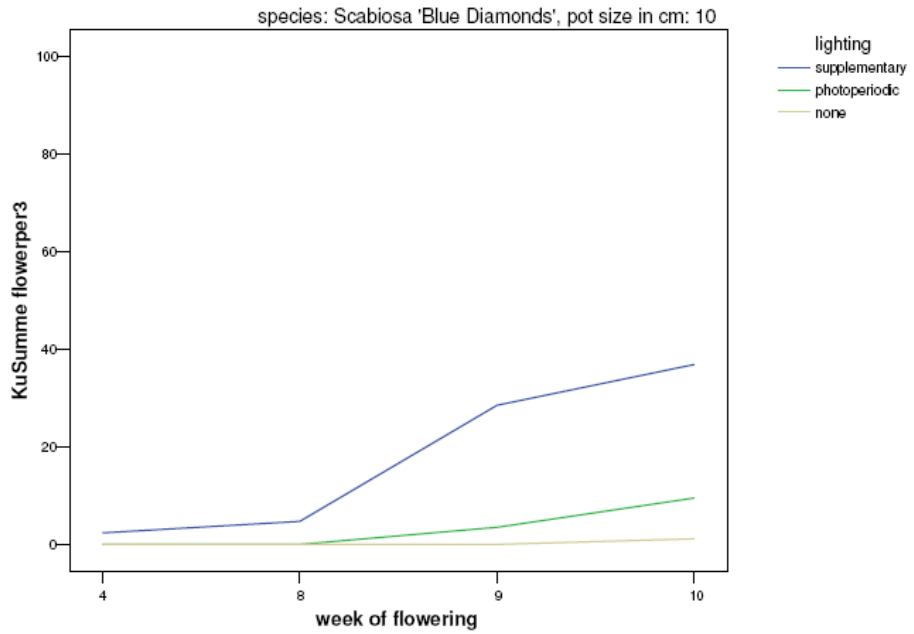


Diagram 9: Percentage of flowering plants relative to the light treatments used in the trial. *Scabiosa japonica* var. *alpina* 'Blue Diamond', 10 cm pot size

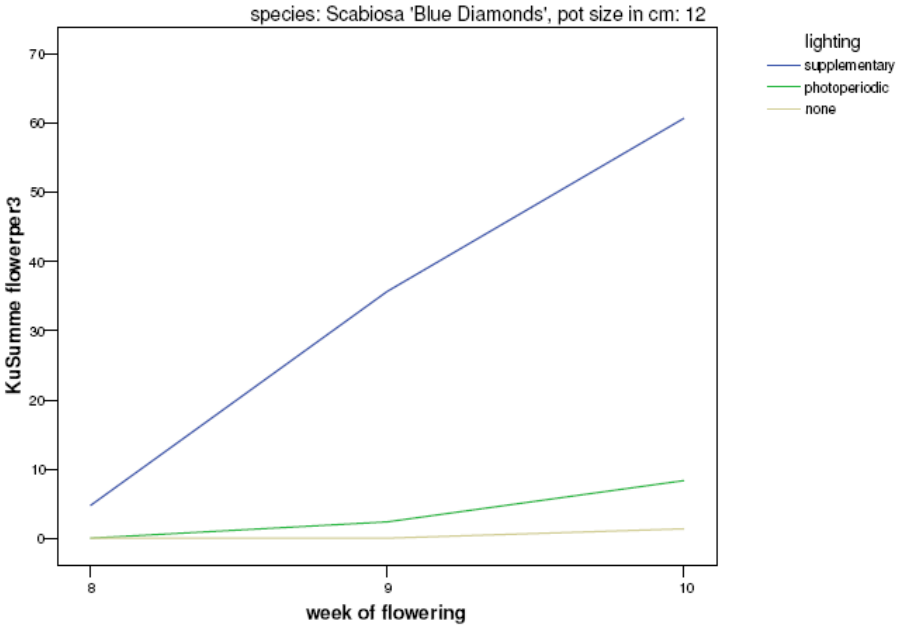


Diagram 10: Percentage of flowering plants relative to the light treatments used in the trial. *Scabiosa japonica* var. *alpina* 'Blue Diamond',12 cm pot size

Height of leaves, height of flowers, number of buds, plant diameter and fresh weight

The plants in 12 cm pots had more fresh weight and buds than plants in the 10 cm pots (Picture 4). All the plants under supplementary light had a higher flower number and fresh weight, more flower buds developed relative to the photoperiodic lighting treatment.

Picture 4: Week 8; *Scabiosa japonica* var. *alpina* 'Ritz Blue' supplementary light; 12 cm and 10 cm pot size

General value

The plants of 'Ritz Blue' in 12 cm pots got better scores than plants in the 10 cm pots. The average was about 6 compared to 4-5. The light treatments had no influence on the general value. The 'Blue Diamond' had a lower average value of 4.

Shelf life test
The shortest shelf life period was 11 days whilst the longest time was 23 days. It depended on the number of buds per plant that were present at the beginning of shelf life (Picture 5). The flower buds on the plants that came into shelf life test in January and early February did not open properly. The buds on the plants from week 9 opened up more and lasted longer.

Picture 5: Week 9 (2003); *Scabiosa japonica* var. *alpina* 'Blue Diamond', supplementary light

***Arenaria montana* (Caryophyllaceae)**

The white flowers of *Arenaria* were attractive in spring arrangements. The shelf life, however, was poor. The plants in 10 cm pots (larger plugs) all flowered and were finished by week 10 (Diagrams 11 and 12). The plants from the supplementary lighting treatment did not have such a good habit. The flower stems were stretched and were quite 'loose' hanging down on from the pots. The plants in the 8 cm pots under ambient daylight looked the best. The date of flowering was recorded when there were 3 to 4 open flowers per pot.

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
There was no difference between pot sizes. Plants under supplementary light were 6 to 11 days earlier than plants under photoperiodic lighting and ambient daylight. The light is not so important for *Arenaria* than the sum of temperatures and even the quality is better with ambient daylight. With forcing from week 50 marketing on Valentine's Day was not possible. With an earlier start of forcing or a slightly higher temperature the crop might come into flower earlier.

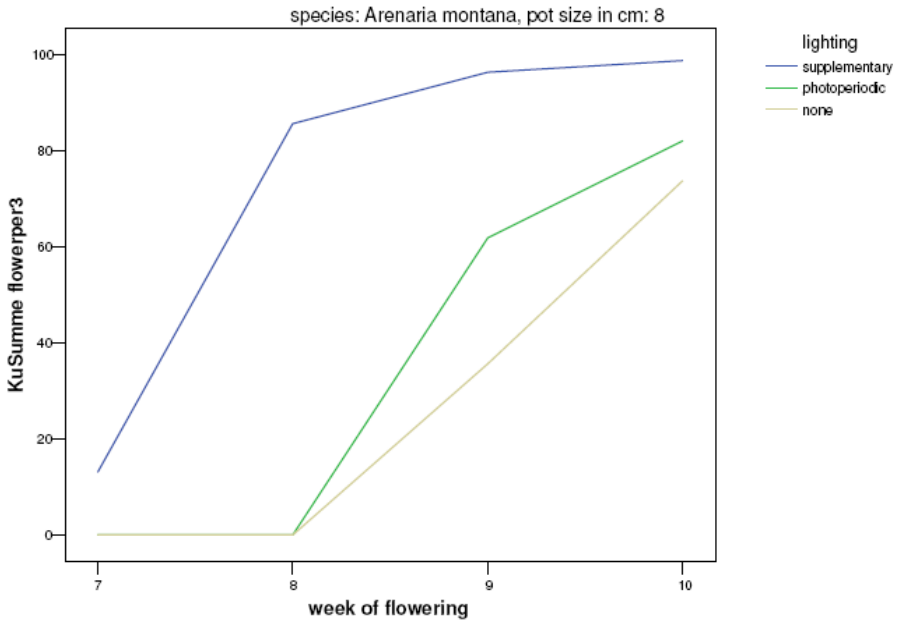


Diagram 11: Percentage of flowering plants relative to the light treatments used in the trial. *Arenaria montana*; 8 cm pot

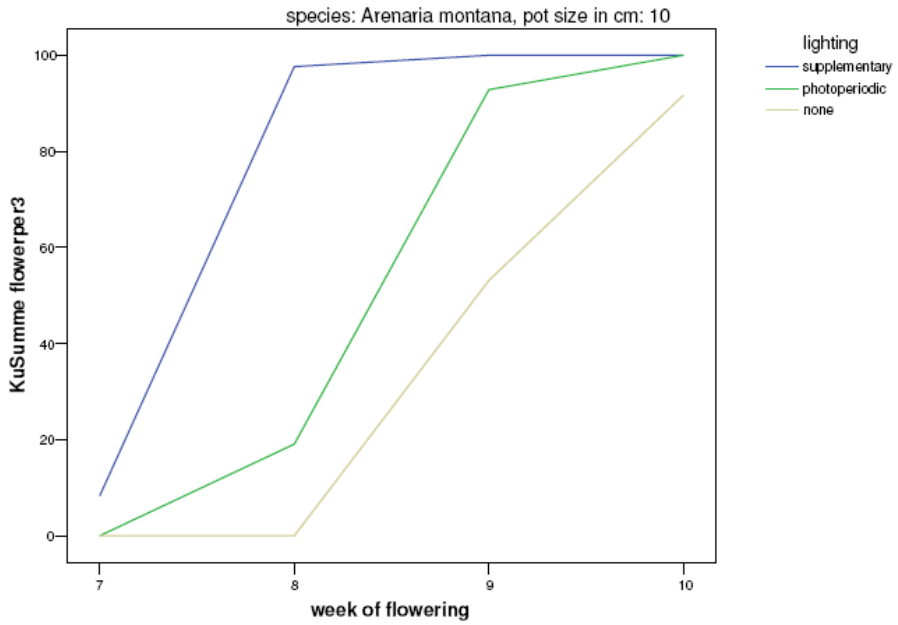


Diagram 12: Percentage of flowering plants relative to the light treatments used in the trial. *Arenaria montana*; 10 cm pot size

Height of leaves, height of flowers, bud number, plant diameter and fresh weight

Plants in 10 cm pots were taller, wider (more open growth) and heavier than plants in 8 cm pots. The plants in 10 cm pots under supplementary and photoperiodic lighting were taller than plants under ambient daylight. Plants in 8 cm pots were only somewhat taller and wider under supplementary light (Picture 8).

Picture 8: Week 8; *Arenaria montana*; 8 cm pot; supplementary, photoperiodic and ambient daylight

General value

As a result of the softer growth the crop received lower general marks. The 8 cm pots got the best general value under ambient daylight. There was a small additional test with pinched plants (week 51) and with supplementary light. Plants stretched in the same way and did not flower until week 10. It is possible that application of chemical growth regulators could result in more upright plants of better habit.

Shelf life test

The shelf life under living room conditions was not tremendous. The white flowers lasted up to 7 to 9 days. It is better to keep them in a cooler place.

***Saxifraga* x *arendsii* 'Carpet Purple' (Saxifragaceae)**

Saxifraga is already a common early spring plant but not often grown for February sales. There are different species with pink, red or white flowers. They produce a lot of flowers above the rosettes and look very attractive. These species are pretty as a single plants or as a colour mix in spring arrangements (Picture 9). The variety 'Carpet Purple' was not that distinct in colour in this trial (colour splitting from seeds). 100% of plants came into flower under supplementary and photoperiodic light (Diagram 13). Only 50% of the plants under ambient daylight had come into flower by week 9, the other half only just showed colour by this time. The date of flowering was recorded when there was 3 to 4 open flowers per pot.

Picture 9: Week 5; *Saxifraga* x *arendsii* 'Carpet Purple', supplementary light

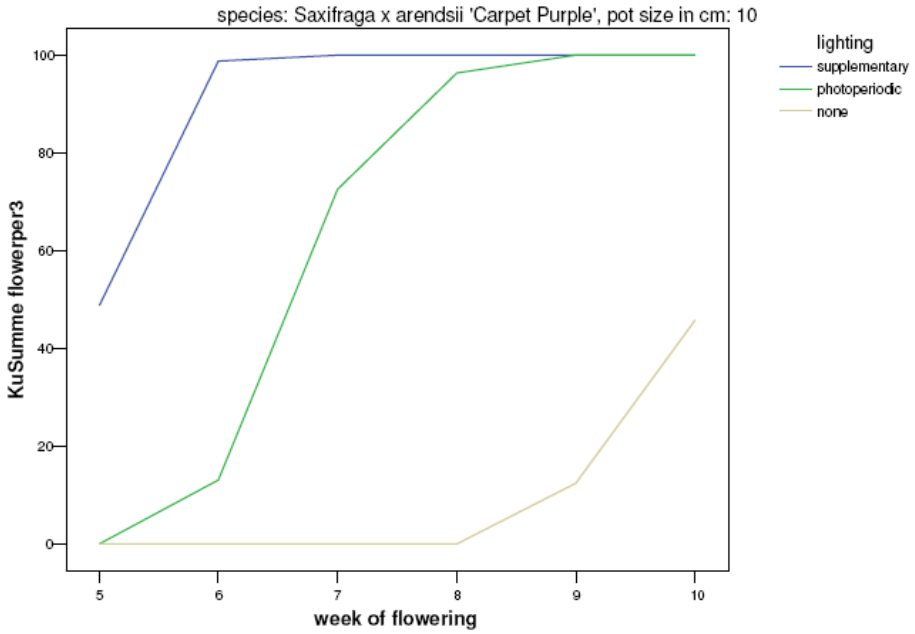


Diagram 13: Percentage of flowering plants relative to the light treatments used in the trial. *Saxifraga* x *arendsii* 'Carpet Purple'

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
Plants under supplementary light were one and a half weeks earlier than plants under photoperiodic lighting and almost 3 weeks earlier than plants with ambient daylight. Supplementary or photoperiodic light was necessary to produce flower by Valentine's Day.

Height of leaves, height of flowers, bud number, plant diameter and fresh weight
Plant and flower heights were higher under supplementary lighting relative to photoperiodic lighting and with photoperiodic light relative to ambient daylight. The plants were larger under supplementary light than under photoperiodic lighting and ambient daylight. The plant habit under supplementary and photoperiodic lighting was too soft.

General value
As a result of the soft growth the plants under supplementary and photoperiodic lighting had lower scores (between 3 and 5). The plants with the best general value were from the ambient daylight treatment and from the polythene tunnel. The plants from the polythene tunnel had more flowers (not documented) than plants from cold glasshouse. The duration of storage was too short to confirm this. *Saxifraga* needs a period of cooling to initiate sufficient flowers.

Shelf life test
Saxifraga performed well under shelf life conditions. The flower colour faded a little and the leaves looked good after an average of 20 days. The shortest time in shelf life was 16 days and the longest time recorded was 21 days.

Delphinium variety 'Guardian Blue' (Ranuculaceae)

The dark blue flower colour of this species was impressive in week 9. Up to that time only the plants under supplementary lighting had come into flower. Plants under photoperiodic lighting showed light blue flower buds and plants under ambient daylight showed buds by week 9. All the plants had initiated flower at the beginning of forcing. Plants were about 100 cm high under supplementary lighting. A low general value was allocated as there was only one flowering stem per pot. Interest was shown more as a cut flower (Picture 10). The vase life was 7 to 11 days. For pot production it would be better to choose a more compact species of Delphinium. With an earlier start to the crop the habit would be expected to be better and there could be more flowering stems per plant.

Picture 10: Week 9; Delphinium Cultivars 'Guardian Blue', supplementary light

***Heuchera purpurea* 'Ruby Bells' (Saxifragaceae)**

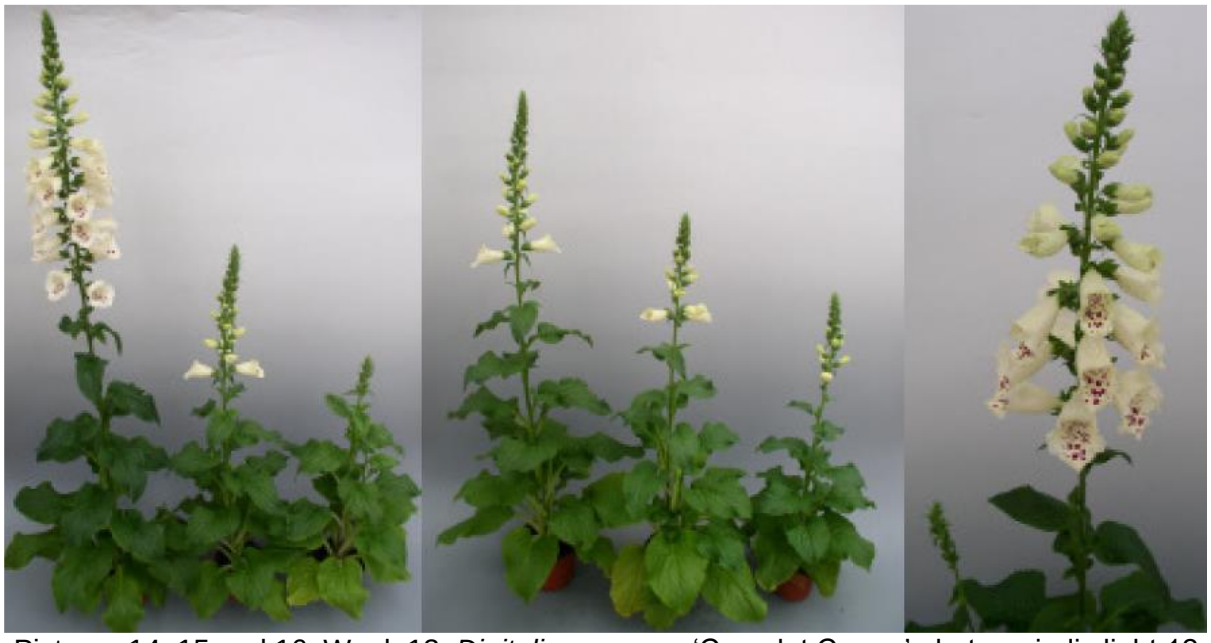
This variety had very dark red flowers on long flower stems. The 12 cm pot was most suitable. Under supplementary lighting, 90% of the plants were in flower by weeks 8 to 10, compared to 40% of plants from the photoperiodic lighting treatment. Plants under ambient daylight had only coloured buds and looked more compact in week 10 (Pictures 11 and 12). Plants from the polythene tunnel had more flowers and buds. Storage was possible in a polythene tunnel or cold glasshouse. Storing plants in a polythene tunnel has the risk that a severe frost may damage the leaves. In shelf life, flowers lasted 14 days and plants with buds at the start of shelf-life kept until 23 days.

Pictures 11 and 12: Week 8; *Heuchera purpurea* 'Ruby Bells' supplementary, photoperiodic and ambient daylight

***Digitalis purpurea* 'Camelot Cream' (Scrophulariaceae)**

This species was fascinating in both flowering and shelf life. The big cream white flowers with a speckled throat were eye-catching. Flowering just about started in week 10 under supplementary lighting. The shelf life was an impressive 4 weeks. This species was too tall for pot production. Plants under photoperiodic lighting and ambient daylight only had buds by week 10 (Pictures 13-16).

Picture 13: Week 8; *Digitalis purpurea* 'Camelot Cream' supplementary, photoperiodic and ambient daylight



Pictures 14, 15 and 16: Week 13, *Digitalis purpurea* 'Camelot Cream' photoperiodic light 12 cm pots.
12 cm, 10 cm, 10 cm+ CCC. Supplementary, photoperiodic and ambient light treatments

Other species / varieties

***Delphinium grandiflorum* 'Summer Stars White' (Scrophulariaceae)**

This species had white-cream flowers. Under supplementary lighting 60 to 70% of the plants came into flower by week 9. The flower was almost 60 cm high and the general value was low. Plants under photoperiodic lighting only had coloured buds whilst plants under ambient daylight had just small buds. The habit was more compact with ambient daylight but the plants were not as uniform. Shelf life was 16 to 18 days.

***Lupinus nanus* 'Gallery Blue' (Fabaceae)**

This species is not recommended for early spring sale. Only under supplementary lighting did the plants develop flowers. From week 8 to week 10 70% of the plants in the 12 cm pots flowered whilst only 20% of the plants in 10 cm pots came into flower. All the plants from the photoperiodic and ambient daylight treatments did not show any flower buds until week 14. It appears that the total amount of light is responsible for the initiation of flowers. The height of the leaves was about 40 cm and the height of the flowers around 50 to 60 cm. There were not enough leaves relative to the plant size and the general value was low. In shelf life test the flowers lasted 10 to 14 days. As a result of their bulk there is always the risk of damaging the leaves / flowers during transport.

***Chaenorhinum origanifolium* 'Blue' (Scrophulariaceae)**

The date of flowering was recorded when 3 to 4 open flowers were noted per plant. In week 8 or 9 about 12 to 20% of the plants were in flower under the supplementary lighting treatment. Plant habit was poor and the general value was low. *Chaenorhinum* is a late crop and appeared more of a bedding plant than an early spring pot plant. Plants under the photoperiodic lighting and ambient daylight treatments only showed coloured buds by week 9. Temperature had more of an influence on growth and flowering than the lighting treatments did. Plants in 10 cm pots had almost double the fresh weight compared to plants in 8 cm pots and they were better of better habit. Shelf life was poor with the blue flowers quickly losing their colour.

***Geranium sanguineum* 'Light Pink' (Geraniaceae)**

This species only generally flowered with one pink flower per plant and never produced a flush of flowers. Under supplementary lighting 40 to 50 % of the plants were flowering by week 10, whilst under the photoperiodic lighting just 10% came into flower. This species reacted to the amount of light and long days. The plants in 10cm pot had double the fresh weight of other plants but did not look good. The stretched stems and little flowers gave them a low general value.

The following 7 plant species were not successful in this trial:

- *Lobelia speciosa* 'F1 Fan Scarlet'
- *Echinacea purpurea* 'Primadonna Deep Rose'
- *Dianthus deltoides* 'Confetti Carmine Rose'
- *Penstemon heterophyllus* 'Electric Blue', Penstemon digitalis 'Mystica'
- *Leucanthemum* x *superbum* 'Crazy Daisy'
- *Coreopsis grandiflora* 'Baby Sun'

No species flowered before week 10 and some didn't flower until week 14. Pictures of each can be seen in the photo album on the DVD in the annex.

2. Fertiliser Trial

The following treatment codes are used during this section:

1 = approx. 200 mg N per plant (1.5 g MannaCote Mini 4 M 19-6-11)
2 = approx. 700 mg N per plant (3.5 g MannaCote Mini 4 M 19-6-11)
3 = approx. 1200 mg N per plant (6 g MannaCote Mini 4 M 19-6-11)

The white/green leafed *Ajuga reptans* 'Variegata' (Lamiaceae) is not reported on since its flowering period was too late and no flowers were recorded before the termination of the trial in week 10. However, plants did not respond positively to treatments 2 and 3 and a high number of plants died.

***Ajuga reptans* 'Rosea' (Lamiaceae)**

This species is an interesting pink flowering plant. The disadvantages are the long stem petioles (Picture 17). Therefore, the general value was low for single plants, but in the creation of arrangements this crop could be still interesting (Picture 18).

Picture 17: Week 6; *Ajuga reptans* 'Rosea', supplementary light

Picture 18: Arrangement with *Ajuga* 'Rosea' (right in background)

Only 80% of plants came into flower. Some plants had flowers which developed in the autumn, but these flowers were not recorded. There were large differences between individual plants in their flowering time (Diagram 14). Flowering occurred over a period of more than 8 weeks. The flowering window was shorter where plants received supplementary lighting. The date of flowering was recorded when three open flowers were present on a flowering stem.

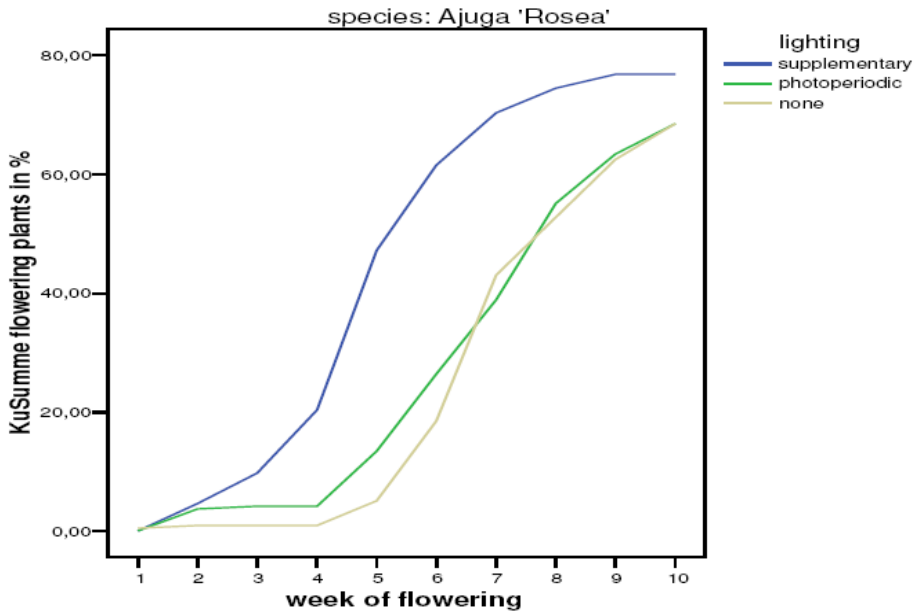


Diagram 14: Percentage of flowering plants relative to the light treatments used in the trial. *Ajuga reptans* 'Rosea'

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
Plants from the polythene tunnel reacted with the fertilizer treatments and their production duration increased in line with the amounts of fertiliser applied. Plants from the cold glasshouse showed the opposite trend and those plants receiving the higher fertiliser levels were first to reach marketing. The reason for this could be that the plants were stressed with the higher fertiliser levels in the glasshouse and made an early stress flower. The difference in duration of crop production was one week between the fertiliser treatments 1 and 2 and fertiliser treatments 2 and 3.

Under supplementary lighting, plants flowered 2 weeks earlier than the photoperiodic lighting and ambient daylight treatments in the case of both the polythene tunnel and glasshouse grown plants. There was no difference in flowering times between the photoperiodic light and ambient daylight treatments. The plants from the cold glasshouse came into flower earlier compared to plants from the polythene tunnel.

Height of leaves, height of flowers, bud number, plant diameter and fresh weight
The fertiliser level had an influence on all parameters. Plants with higher levels of fertiliser had more leaves, flowers, a larger plant diameter and a higher fresh weight. The exception was fertiliser treatment 3 where plants had been grown under glass. It is believed this was due to stress levels on the plants. Light treatments influenced both the height of the flowers and the fresh weight. Supplementary lighting gave rise to taller flowering stems, but the plants had less fresh weight than the plants from the photoperiodic and ambient daylight treatments because of the shorter duration of crop.

Shelf life test
Ajuga reptans 'Rosea' had a good shelf life. The pink flower colour became a little faded but the leaves looked good. The shelf life was influenced mainly by the fertilizer treatments. Plants with a higher level of fertiliser had a shorter shelf life (Table 8).

Table 8. Influence of the fertiliser level and place of vernalisation on the shelf life of *Ajuga reptans* 'Rosea'

	Shelf life in days					
Treatment	Polythene tunnel			Cold glasshouse		
	mid	min	max	mid	min	max
Fertiliser 1	23	20	26	21	17	25
Fertiliser 2	19	14	26	16	11	21
Fertiliser 3	17	13	23	15	11	23

***Ajuga reptans* 'Mini Mahagoni' (Lamiaceae)**

This species performed very well. The plants were compact, with a good habit and the blue flower colour was very distinct against the bronze foliage. (Picture 19).

100% of the plants came into flower. The date of flowering was recorded when three open flowers were visible on a flowering stem.

Picture 19: Week 7; *Ajuga reptans* 'Mini Mahagoni'

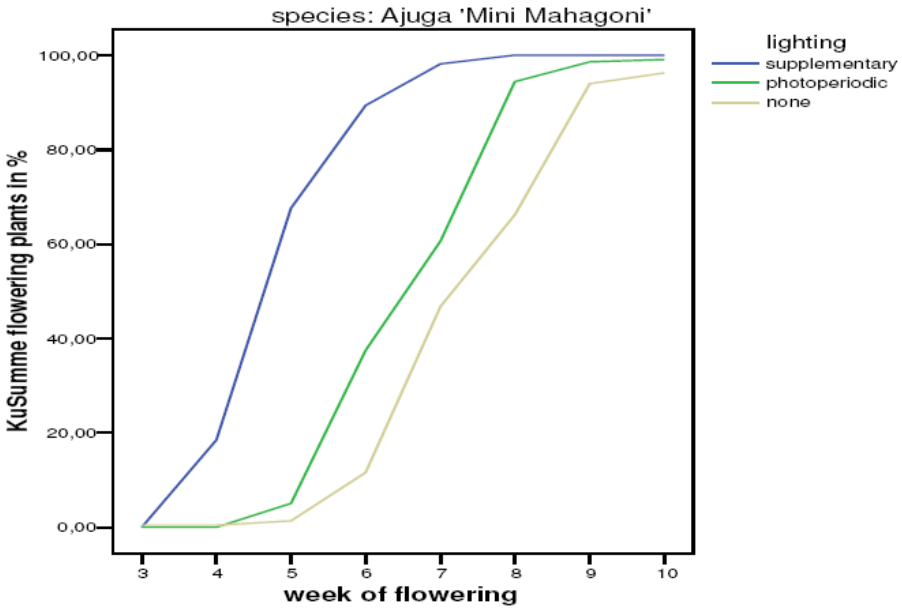


Diagram 15: Percentage of flowering plants relative to the light treatments used in the trial. *Ajuga reptans* 'Mini Mahagoni'

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
The plants from fertiliser treatment 2 were half a week later into flower than plants from treatments 1 and 3. This was not deemed commercially significant. Plants grown under polythene or glass had no interaction with the fertiliser treatments.
Plants exposed to supplementary lighting from the polythene tunnel were 2 weeks earlier into flower compared to the photoperiodic lighting treatment, and almost 3 weeks earlier compared to the ambient daylight treatment (Diagram 15). Plants from the cold glasshouse reacted with less of a difference. Plants from the supplementary lighting treatment were a little over one week earlier than the photoperiodic lighting treatment and 2 weeks earlier than ambient daylight treatment. Plants from the cold glasshouse were about 1 week earlier than plants from the polythene tunnel.

Height of leaves, height of flowers, bud number, plant diameter and fresh weight
The fertiliser and storage treatments had an influence on plant height, diameter and fresh weight. Plants from the polythene tunnel were taller and wider compared to plants from the cold glasshouse. Plants from the polythene tunnel had a better growth with fertiliser treatments 2 (mid) and 3 (high) than plants with treatment 1 (low).

Plants from the cold glasshouse reacted differently to the fertiliser treatments. The plants with the highest fertiliser levels were shorter and smaller than the plants with from fertiliser treatments 1 and 2. The lighting treatments had no influence.

The height of the flower stems was influenced by the storage, fertiliser and light treatments. The plants from polythene tunnel had taller flowers with fertiliser treatments 2 and 3 compared to fertiliser treatment 1. The lighting treatments did not have a large effect. Only plants under supplementary lighting and fertiliser treatment 3 had taller flowering stems. In contrast the plants from the cold glasshouses had taller flowering stems with fertiliser treatments 1 and 2 compared to plants with fertiliser treatment 3.

The reaction of plants from the polythene tunnel and cold glasshouse to the fertiliser levels was different. Plants from the polythene tunnel were better with the higher fertiliser levels than plants from the glasshouse. The reasons could be due to leaching by watering from over head and the lower temperatures experienced in the polythene tunnel. In coated base fertilizers like MannaCote the release of the nutrients is strongly dependent on the temperature. In the glasshouse the water was applied via an ebb and flow system. This factor combined with the higher average temperature probably resulted in accumulation of nutrients and salt stress to the plants in the glasshouse.

General value
The plants from the polythene tunnel had better scores than plants from the cold glasshouse, but only at the higher fertiliser levels (2 and 3). Plants from the cold glasshouse had scores between 6 and 7.5. The best scores, with an average of 8.5, were for the plants grown in the polythene tunnel at the highest fertiliser level 3 (Picture 20 and 21).

Picture 20: Week 4; *Ajuga reptans* 'Mini Mahagoni', glasshouse, supplementary light. Fertiliser level 1, 2 and 3

Picture 21: Week 4; *Ajuga reptans* 'Mini Mahagoni', polytunnel, supplementary light. Fertiliser level 1, 2 and 3

Shelf life test
There was no apparent effect of lighting. Increased fertiliser levels resulted in a decrease in shelf life (Table 9).

Table 9. Influence of the fertiliser level and place of vernalisation on the shelf life of *Ajuga reptans* 'Mini Mahagoni'

	Shelf life in days					
Treatment	Polythene tunnel			Cold glasshouse		
	mid	min	max	mid	min	max
Fertiliser 1(low)	18	17	21	16	14	18
Fertiliser 2(mid)	16	14	17	14	11	16
Fertiliser 3(high)	13	11	16	13	13	14

***Androsace septentrionalis* 'Star Dust' (Primulacea)**

These white flowering plants had been successful in former trials but there was no experience with different fertiliser levels. *Androsace* has a high value for spring previous arrangements (Pictures 22, 23 and 24).

Pictures 22, 23, 24: Arrangements with *Androsace septentrionalis* 'Star Dust'

Due to losses during precultivation and storage, not all plots had 12 plants at the beginning of forcing. All the plants flowered. The date of flowering was recorded when three open flowers were present on a flower stem.

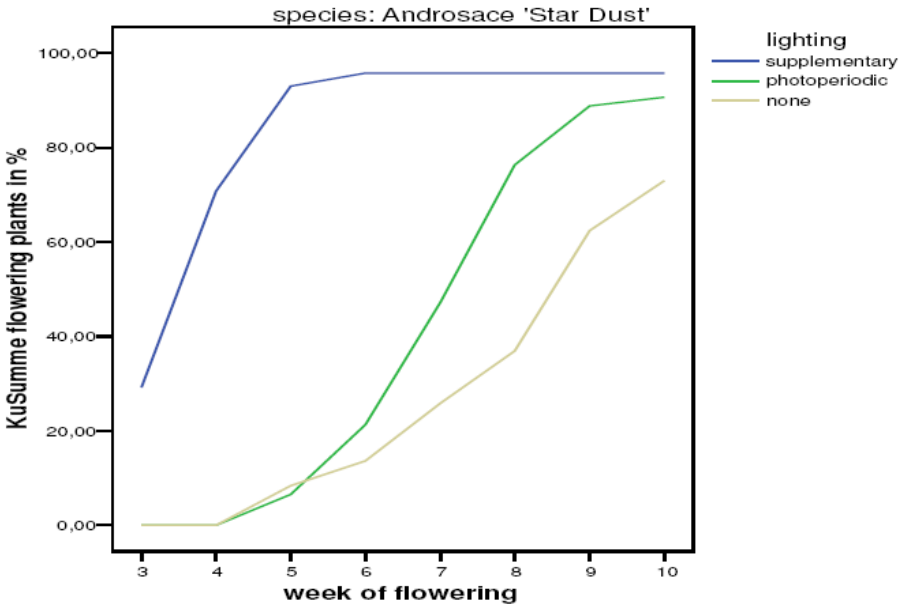


Diagram 16: Percentage of flowering plants relative to the light treatments used in the trial. *Androsace septentrionalis* 'Star Dust'

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)

All the factors examined had an influence on the duration of the crop. In the case of plants from the polythene tunnel, fertiliser treatment 1 was two weeks earlier into flower than treatments 2 and 3. In the case of the plants from the glasshouse, fertiliser treatment 1 was two weeks earlier into flower than treatment 2, but treatment 3 was approximately 1 week earlier.

Plants from the polythene tunnel were on average one week earlier into flower than plants from the cold glasshouse (Diagram 16).

Plants under supplementary lighting were 3 to 4 weeks earlier than plants under photoperiodic and ambient daylight. Flowering started in week 3 compared to week 7 and 8 respectively (Pictures 26 and 27). Plants under the photoperiodic and ambient daylight treatments from the polytunnel were a little earlier than plants from the cold glasshouse. With supplementary lighting the plants began flowering at the same time.

Picture 26: Week 4; *Androsace septentrionalis* 'Star Dust', polytunnel, supplementary light. Fertiliser level 1, 2 and 3

Picture 27: Week 4; *Androsace septentrionalis* 'Star Dust', cold glasshouse, supplementary light. Fertiliser level 1, 2 and 3

Height of leaves, height of flowers, bud number, plant diameter and fresh weight
All plants from fertiliser treatments 1 and 2 had more leaves and flowers than plants from fertiliser treatment 3. The fresh weight of the plants was different between plants from the polythene tunnel and the cold glasshouse, which had higher fresh weights. The diameter and fresh weight of plants from the cold glasshouse with fertiliser treatment 3 were a lot lower than plants with fertiliser treatments 1 and 2. The light treatments did not have a significant influence. Plants under supplementary and photoperiodic lighting had stretched flowering stems compared to plants under ambient daylight.

General value
All plants from fertiliser treatments 1 and 2 achieved higher scores than plants from treatment 3. The best development (especially the number of flower stems) was noted in plants from the supplementary lighting treatment. Plants were uniform in habit and maturity (general value 8 - 9). The plants from the low fertiliser treatment looked the best.

Picture 28: Week 4; *Androsace septentrionalis* 'Star Dust', fertiliser 1; supplementary light. Storage cold glasshouse and polythene tunnel

Shelf life test
The shelf life of Androsace was a little over 14 days. Most of the buds developed to fully open flowers. The flowers gave rise to seeds and leaf wilting was also noted along with this. Plants from fertiliser treatment 3 and fertiliser treatment 2 collapsed after a short time in shelf-life (Table 10). The leaves wilted and the flower stems collapsed. The reason for this is probably the high output of nutrient salts from the base fertiliser under the higher temperatures in the shelf life test.

Table 10. Influence of the fertiliser level and place of vernalisation on the shelf life of *Androsace septentrionalis* 'Star Dust'

	Shelf life in days					
Treatment	Polythene tunnel			Cold glasshouse		
	mid	min	max	mid	min	max
Fertiliser 1(low)	16	14	18	15	13	19
Fertiliser 2(mid)	13	10	16	11	7	16
Fertiliser 3(high)	8	5	16	4	2	7

***Lithodora diffusa* 'Heavenly Blue' (Boraginaceae)**

The colour of flowers from this species is very vibrant (Picture 29).

Picture 29: The vibrant blue flower colour of *Lithodora diffusa* 'Heavenly Blue'

The *Lithodora* reacted very sensitively to higher amounts of base fertiliser. There was a big loss of plants especially with the fertiliser treatments 2 and 3 in the precultivation period. This continued through the forcing period. The following diagrams (Diagrams 17 and 18) show the flowering response under the different light treatments of the surviving plants only. 100 % of the plants under supplementary lighting flowered by the 6 March. The plants from the ambient daylight treatment were not as advanced at this stage but had coloured buds.

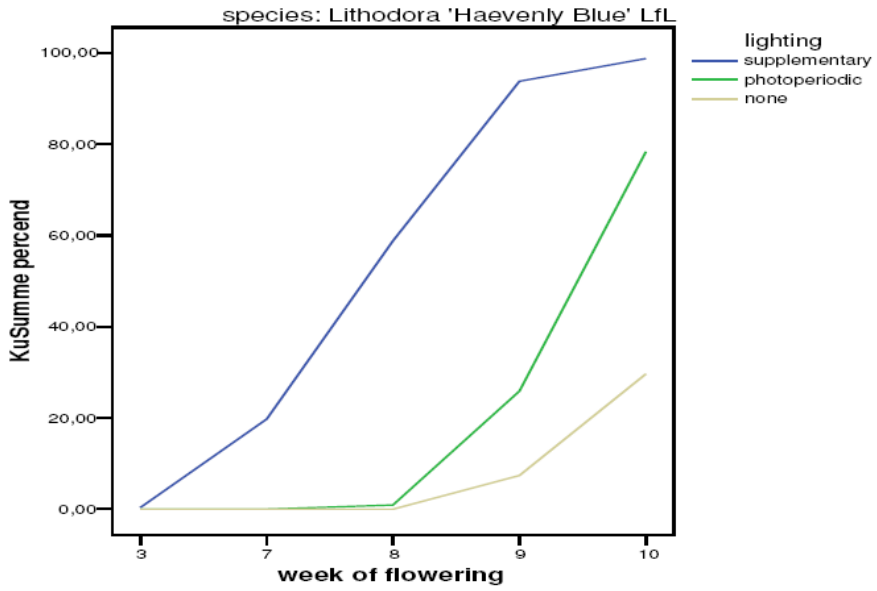


Diagram 17: Percentage of flowering plants relative to the light treatments used in the trial. *Lithodora diffusa* 'Heavenly Blue'; LfL

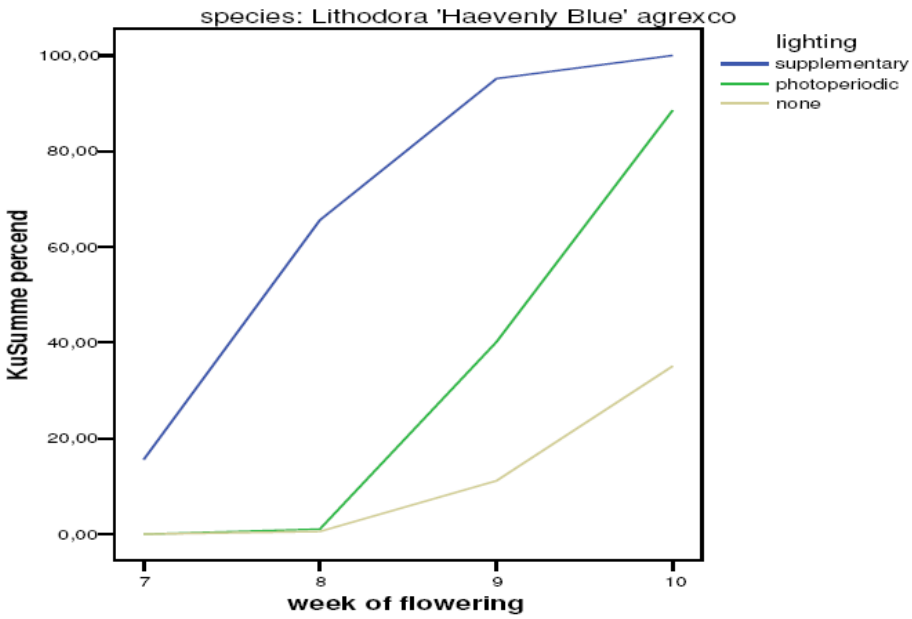


Diagram 18: Percentage of flowering plants relative to the light treatments used in the trial. *Lithodora diffusa* 'Heavenly Blue'; AGREXCO

Duration of crop (weeks from the start of forcing in week 50 to the flowering date)
The duration of the crop was not influenced by the fertiliser level applied to the plants. The plants under supplementary lighting were one and a half weeks earlier than plants under photoperiodic lighting or ambient daylight. The date of flowering was recorded with 3-4 open flowers on a plant.

Picture 30: Week 9; *Lithodora diffusa* 'Heavenly Blue', fertiliser 1, cold glasshouse supplementary, photoperiodic and ambient daylight

Height of leaves, height of flowers, bud number, plant diameter and fresh weight
Storage and fertiliser level had no influence on plant height or diameter. Plants under supplementary lighting were taller and wider than plants under photoperiodic lighting and ambient daylight. The plants from the polythene tunnel were wider than plants from the cold glasshouse. The plants from the polythene tunnel also developed more branches.

Fertiliser level and storage influenced the fresh weight of the plants. Plants from the polythene tunnel were heavier than plants from the cold glasshouse. Within the plants from the polythene tunnel those with the higher fertiliser levels showed higher fresh weight. This difference was not found in the plants from the glasshouse probably due to the lower light level or the salt stress induced by the base fertiliser addition coupled with the higher temperatures. Plants had greater fresh weight under supplementary lighting compared to the other light treatments.

General value
Storage and lighting influenced the general value. Plants from the polythene tunnel and with ambient daylight got better marks than plants from cold glasshouse and other light treatments.

Shelf life test
The shelf life of *Lithodora* was about 14 days. The flower colour faded under the high temperatures and the low light level. Plants from the ambient daylight treatment did not go into shelf life test. Plants from the supplementary and photoperiodic light treatments showed nearly the same shelf life (Table 11).

Table 11. Influence of the fertiliser level and place of vernalisation on the shelf life of *Lithodora diffusa* 'Heavenly Blue'

	Shelf life in days					
Treatment	Polythene tunnel			Cold glasshouse		
	mid	min	max	mid	min	max
Fertiliser 1(low)	15	12	18	14	13	14
Fertiliser 2(mid)	12	10	14	12	11	16
Fertiliser 3(high)	10	8	11	11	10	14

3. Additional Species by Kieft Seeds Trial

Only those species that showed potential for commercial production are included in the report. Pictures from all species are available in the ULEAD PhotoImpact album on DVD isted in the annex. (Available from HDC on request)

***Anacyclus pyrethrum* var. *depressus* 'Spring Carpet'**

The flowers of this species are interesting because of the white colour on top side and purple colour on the underside of the flower petals. This makes it an attractive plant either as a single plant or in arrangements. 25% of the plants were in flower by Valentine's Day and 75 % by the end of week 8. The date of flowering was recorded when three open flowers per pot were present.

The plant habit of the species was variable. There were more plants with long stretched branches than upright and compact growing plants. As a result the general value was in the lower range. In former years the variety *Anacyclus* 'Silberkissen' from Jelitto was more successful with its compact growth (Pictures 31 and 32). With supplementary lighting and a week of higher temperatures at the beginning of the forcing period the plants flowered in week 8. Without higher temperatures flowering occurred in week 9 and with ambient daylight flowering occurred in week 11.

Picture 31: Week 7; *Anacyclus pyrethrum* var. *depressus* 'Spring Carpet', supplementary light

Picture 32: Week 8 (2003); *Anacyclus pyrethrum* var. *depressus* 'Silberkissen', supplementary light

***Aquilegia vulgaris* ('Clementine' series)**

The characteristic frilled flowers of this species were typically 40 to 50 cm in height (a little too high). All the varieties were sown in week 32. The week of potting was divided between weeks 36 and week 37. Only plants that were potted in week 36 and stored in a cold glasshouse initiated a flower. Flowering started in weeks 6 and 7. All the other plants did not reach an acceptable quality. There appears to be a need for a definite number of leaves before flower initiation occurs. The shelf life was longer compared to *Aquilegia* F1 Spring Magic, flower buds continued to open up on the flowering stem and the plants remained for 19 days in shelf life room (Picture 40).

Picture 33: Week 7; *Aquilegia vulgaris* 'Clementine Rose', supplementary light

***Barbarea rupicola* 'Sunnyola'**

This crop is interesting because of the yellow flowers borne just above the dark green well shaped leaves. With supplementary lighting plants flowered in weeks 5 and 6. The plants from the polythene tunnel had a longer flower stem (Picture 34), whilst plants from the cold glasshouse appeared more 'stunted'. The shelf life was 10 days.

Picture 34: Week 5; Barbarea rupicola 'Sunnyola', supplementary light

***Calceolaria biflora* 'Goldcap'**

The plant produces yellow tender flowers over a rosette of leaves. This species is not as bright as the common Calceolaria on the market but could offer a niche product. Plants from the polythene tunnel were 1 week earlier into flower (week 7) than plants from the cold

glasshouse. Plants from the cold glasshouse developed a larger rosette of leaves. The shelf life depended on how many buds were present at the start of shelf life, the average the shelf-life being 15 days.

Picture 35: Week 7; Calceolaria biflora 'Goldcap'; supplementray light

***Erysimum perovskiskianum* 'Goldrush'**

This species was early into flower. Plants potted in week 34 and stored in a cold glasshouse started flowering in week 51 and plants stored in the polythene tunnel in week 1. Plants stored in the cold glasshouse tended to have a single tall flower stem, whereas plants stored in the polythene tunnel had around 5 flowering stems and a better general value overall (Picture 36). The shelf life was 14 to 16 days.

Picture 36: Week 7; *Erysimum perovskiskianum* 'Goldrush'; supplementary light

***Chaenorhinum origanifolium* 'Summer Skies'**

This blue-violet flowering crop was late into flower, week 9 to 10. The plants were a little soft and leggy and were not as attractive. Shelf life was 14 to 16 days. The blue flowers faded to white very quickly.

***Erigeron karvinskianus* 'Stallone'**

This species was only really suitable for mixed spring arrangements. Under supplementary lighting the plants from the polythene tunnel were earlier into (week 6 / 7) than plants from the cold glasshouse (week 7 / 8), but plants from the cold glasshouse were better in habit. The growth under supplementary lighting was too weak and the general value was low. The shelf life was long, 21 to 31 days. All flower buds opened up in shelf life.

***Mimulus* x *hybridus* (Bounty series)**

There were four colours in trial. All were potted in week 35. The yellow variety was first into flower in weeks 5-6 followed by the pink and orange flowered varieties in weeks 6-7 and red in week 7-8. The shelf life was poor, only 4 to 8 days.

All the other species tested in this additional trial were not mentioned because of late flowering, unattractive habit or short shelf life. Data and pictures are included in the ULEAD PhotoImpact album on DVD listed in the annex. (Available from HDC on request)

Conclusions

UK Trial at Pillnitz

From the 21 species included in the UK trial the following are suitable directly as pot plants for early season sale at Valentine's Day:

- *Aquilegia* 'Spring Magic Blue & White'
- *Geum coccineum* 'Cooky'
- *Arenaria montana*
- *Saxifraga* x *arendsii* 'Carpet Purple'

A couple of these varieties will need some alterations to their cultivation schedule to realise their full potential. Start of pre-cultivation, duration of cold storage and the lighting treatment should be optimised for each variety.

Still further effort is necessary to make the following varieties suitable as pot plants for early season sales, but they still show useful potential.

- *Delphinum* variety 'Guardian Blue'
- *Digitalis purpurea* 'Camelot Cream'
- *Heuchera purpurea* 'Ruby Bells'
- *Papaver nudicaule* 'Garden Gnome'
- *Scabiosa japonica* var. *alpina* 'Ritz Blue' or better 'Diamond Blue'

The application of plant growth regulators, use of larger pots and the search for other breeding lines could be important steps.

These species are probably not suited for sale as individual plants and the best chances of marketing them may be to offer them in ready mixed containers. For this use further research is essential in order to:

- synchronise exactly the cultivation of different plant species
- develop best selling combinations
- include further species / varieties

Crops targeted for Valentine's Day and for use indoors should be produced in smaller pot sizes. The taller crops in bigger pot sizes could be a product for early March, for cooler places or terraces even if there will be the danger of frost.

The following summaries are provided for the species with most merit:

Recommendation for Aquilegia F1 Spring Magic 'Blue and White'
Potting should take place earlier, e.g. in weeks 26 to 30 (9-11cm pot). Outdoor conditions might be better for improved plant habit / compact shape until the first frosts. Storage should take place for about 9 weeks (week 40 to 50) in a cold glasshouse (heating: 4°C, venting: 6°C). Plants with 10 weeks cooling had more pronounced flower stems and had double the amount of flowers per plant. Plants were 3.5 weeks earlier into flower than plants without cooling (9 weeks in glasshouse 14°C).

Recommendation for Geum coccineum 'Cooky'
Start early in week 30 to 35 to get more growth and more flowers. Storage is possible in a cold glasshouse or polythene tunnel. Supplementary and photoperiodic light have the advantage that more plants come into flower over a shorter time and before Valentine's Day, but ambient daylight is sufficient for early spring flowering (under Pillnitz conditions). Until now growth regulators were not used but they could be tested to try and reduce the length of the flowering stems. There is already an ongoing breeding programme trying to reduce the habit with this species.

Recommendation for Arenaria montana
Arenaria could be a small accessory crop, grown for spring arrangements. The species appeared better suited to cool conditions. Start potting from week 40 into 8 or 9 cm pots and let the plants root in higher temperatures (14°C) for 2 weeks. Keep them in a cold glasshouse for storage and start forcing in week 50. Arenaria responds to the level of temperature provided so, if possible, expose the plants to higher temperatures for a couple of days. With ambient daylight, the plants will flower from week 9 to 10.

Recommendation for Saxifraga x arendsii
In former trials the variety 'Peter Pan' grown from cuttings was more successful because it stayed compact and the flower stems did not stretch above the leaves. Start potting week 31 and grow them outdoors or in a cold glasshouse. With plugs grown from seed, potting can be carried out in week 35. Pot sizes from 9 to 12 cm are can be used. Storage can take place in a polythene tunnel or cold glasshouse from week 40 to week 50. Start forcing in week 50. Marketing in February is possible with supplementary light or photoperiodic light and with forcing temperatures between 10°C to 12 °C. To avoid soft growth it is possible to grow the plants at 4°C with supplementary light and force plants into flower in week 7 to 8. Plants that were grown at 4°C and with ambient daylight at Pillnitz flowered in week 11 to 12. With ambient daylight and 10 °C flowering occurred in week 8 to 10.

Recommendation for Papaver nudicaule 'Garden Gnome'
Potting should be around 5 weeks earlier (week 35, into a 10 cm pot) to get more growth and more flowers. As a result of the short shelf-life of the flowers (7 days), there needs to be enough buds present on the plant at the start of shelf-life. More buds were present when supplementary light was applied in the forcing period. Storage in a cold glasshouse is better for the development of leaves than in an unheated polythene tunnel. The tall flower stem restricts the number of shelves per trolley. It could be that the breeders have an alternative compact species with the same bright flower colour range.

Recommendation for Scabiosa japonica var. alpina 'Ritz Blue' and 'Blue Diamond'
Start potting earlier (week 35) to develop more leaves and more flowers. The pot size should be 10cm or 11 cm. The cold storage period should be from week 40 to week 50 in a polythene tunnel or cold glasshouse (heating: 4°C, venting: 6°C). Supplementary lighting is necessary for successful cropping in weeks 9 to 10.

Fertiliser Trial

The five varieties each reacted in a different way in the trial: *Androsace septentrionalis, Ajuga* 'Variegata' and *Lithodora diffusa* 'Heavenly Blue' were all very sensitive to the high level of nitrogen (1200 mg N per pot). The optimum for these varieties was in the range of 200 to 300 mg N per plant. Ajuga 'Rosea' and 'Mini Mahagoni' were not so sensitive to over-fertilisation. At the lowest fertilisation level they actually showed slight deficiency symptoms. The optimum for these varieties was in the range between 500 and 700 mg N per plant.

Higher temperatures during the storage of the plants and during the forcing period appeared to result in higher release of nutrients, over-fertilisation and salt stress. All the varieties involved in this trial except for *Ajuga* 'Variegata' could be produced for early season sales at Valentine's Day as single pot plants or in mixed combinations:

- *Ajuga reptans* 'Mini Mahagoni'
- *Ajuga reptans* 'Rosea'
- *Androsace septentrionalis* 'Stardust'
- *Lithodora diffusa* 'Heavenly Blue'

Recommendation for Ajuga reptans 'Rosea'
The crop can start later than week 28 (cuttings) to avoid premature flowering in the autumn. They can be grown in a cold glasshouse. The fertiliser level should be between 200 and 700

mg N per plant to ensure earlier flowering, good plant size and a long shelf life. Supplementary light is necessary for selling in February.

Recommendation for Ajuga reptans 'Mini Mahagoni'
Stick cuttings in week 28 and pot in week 33. The fertiliser level should be between 500 - 700 mg N per plant but is it better to liquid feed than provide the nutrients via higher levels of base fertiliser. Storage is possible in a polythene tunnel or a frost-free glasshouse. Plants can be brought into flower successfully using supplementary lighting. Plants from the polythene tunnel reached flowering with both photoperiodic lighting and ambient daylight in the forcing period. Start the programme one or two weeks earlier to ensure flowering in February when the crop is grown using only ambient daylight.

Recommendation for Androsace septentrionals 'Star Dust'
Ideally sow in week 31 and pot in week 33. For the best results the fertiliser level should be at a low level and not above 200 mg N per plant. It is recommended to use liquid fertilisers as these can be better controlled in their dosage at the different plant growth stages. It is possible to have flowering plants in February using just ambient daylight but the crop is not as uniform as plants grown under supplementary lighting. Supplementary lighting allows earlier flowering than ambient daylight. Plants grown in a polythene tunnel will be more compact and will flower earlier.

Recommendation for Lithodora diffusa 'Heavenly Blue'
Lithodora is very sensitive to high amounts of base fertiliser especially during storage and forcing. The fertiliser level should not be above 200 mg N per plant. The potting of plants was late in week 35 and it was surprising that plants still made such good growth under outdoor conditions, even plants stored in the polythene tunnel. With one plant in a pot, a pot size of 9 or 10 cm would be most appropriate. In former trials the recommendation was to have three plants in a 12 cm pot. Three plants in a pot created a better shape, with more flowers at the beginning. Potting should be undertaken 5 to 7 weeks earlier to get good growth and plant size before storage. The crop branched more in the polythene tunnel. The temperatures during the cool phase should not go below - 5°C. To achieve flowering in February using ambient daylight, the forcing period has to start in week 50 and temperatures should be higher for one week (approximately 20 °C). *Lithodora* needs a period of cold storage to initiate flowers and reacts to temperature during forcing. With forcing temperatures at 10 to 12 °C the crop will be ready in week 9 to 10. *Lithodora* is susceptible to high calcium levels and should be potted in a substrate with lower pH of about 4.5 to 5.5.

Additional Species by Kieft Seeds Trial

28 varieties from Kieft seeds were tested and out of these the following ones were deemed suitable for commercial consideration:

- *Anacyclus depressus* ' Spring Carpet' or better 'Silberkissen'
- *Barbarea rupicola* 'Sunnyola'
- *Calceolaria biflora* 'Goldcap'
- *Erysimum perovskianum* 'Goldrush'
- *Chaenorhinum origanifolium* 'Summer Skies'
- *Erigeron karvinskianus* 'Stallone'
- *Mimulus* x *hybridus* 'Bounty' series

Further work will be required to evaluate these species.

Technology transfer

- A formal presentation was made to the Technical Committee of the BBPA on April 13 2006.
- An HDC Project News article was published in the December 2006 edition.
- A formal presentation was made at the BBPA AGM technical seminar on 8 February 2007.
- An open invitation for growers to visit the trial was made during February 2007.
- A production guide based on the information generated by the Pillnitz work will be published by the HDC during spring 2007.

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Appendices

Appendix 1

Contents of the annex on DVD

data files	sheets	Contents
UKdata.xls	assortment	list of the assortment
	01 …21	datas of the single varieties
	all data	combined data of all varieties
	shelflife	datas of shelf life test from UK trial
AnnexUK.ppt		tables and diagrams for each single variety in UK trial
UKpresentation.ppt		transparencies of the presentation at the meeting in Arundel on 4/14/06 from Ute Hoffman
UKpics.exe		selfextracting and browser readable photo album of the UK trial
Fertdata.xls	treatments	code for assortment, potsize, fertiliser and storage treatments
	data	datas of fertilisation trial
	shelflife	datas of shelf life test from Fertilisation trial
AnnexFert.ppt		tables and diagrams for each single variety and treatment in fertilisation trial
Fertpics.exe		selfextracting and browser readable photo album of the Fertilisation trial
Kieftdata.xls	assortment	Assortment and additional information of pre-cultivation
	data and shelf life	datas of fertilisation trial including datas od shelf life test
Kieftpics.exe		selfextracting and browser readable photo album of the additional assortment Kieft Seeds
Valentine 2006.ab3		ULEAD PhotoImpact album of all picture with the option of automatic search (needs special ULEAD software)
Report.pdf		this technical report as pdf file

Appendix 2 – Germination and Cropping Details from Kieft Seeds Species Trial

seed No	label	firm	species	variety	common name german	family	month	date of sawing (week 32)	date of germ.	date of potting the seedlings	in week
31	**F 01**	Kieft	Agastache astromontana	Pink Pop	Garten Duftnessel	Lamiaceae	.7-9	12.8.05	26/8/05	30/08/05	35
20	**F 02**	Kieft	Anacyclus depressus	Spring Carped	Scheinkamille	Asteraceae	.4-6	12.8.05	22/8/05	26/08/05	34
21	**F 03**	Kieft	Aquilegia vulgaris	Clementine® Blue	Gefülltblühende Gartenakelei	Ranunculaceae	.5-6	12.8.05	5/9/05	12/09/05	37
22	**F 04**	Kieft	Aquilegia vulgaris	Clementine® Dark Purple	Garten Akelei	Ranunculaceae	.5-6	12.8.05	2/9/05	12/09/05	37
24	**F 05**	Kieft	Aquilegia vulgaris	Clementine® Red	Garten Akelei	Ranunculaceae	.5-6	12.8.05	2/9/05	12/09/05	37
25	**F 06**	Kieft	Aquilegia vulgaris	Clementine® Rose	Garten Akelei	Ranunculaceae	.5-6	12.8.05	5/9/05	07/09/05	36
23	**F 07**	Kieft	Aquilegia vulgaris	Clementine® Salmon Rose	Garten Akelei	Ranunculaceae	.5-6	12.8.05	2/9/05	07/09/05	36
26	**F 08**	Kieft	Aquilegia vulgaris	Clementine® White	Garten Akelei	Ranunculaceae	.5-6	12.8.05	23/8/05	30/08/05	35
27	**F 09**	Kieft	Barbarea rupicola	Sunnyola	Barbarakraut	Brassicaceae	.7	12.8.05	26/8/05	30/08/05	35
29	**F 10**	Kieft	Calceolaria biflora	Goldcap	Zweiblütige Pantoffelblume	Scrophulariaceae	.6-7	12.8.05	24/8/05	30/08/05	35
32	**F 11**	Kieft	Chaenorhinum origanifolium	Summer Skies	Klaffmäulchen, Klaffmund	Scrophulariaceae	.7-8	12.8.05	26/8/05	07/09/05	36
28	**F 12**	Kieft	Chiastophyllum oppositifolium	Solar Yellow	Goldtröpfchen, Walddickblatt	Crassulaceae	.6-7	12.8.05	26/8/05	12/09/05	37
33	**F 13**	Kieft	Digitalis grandiflora	Dwarf Carillon	Großblütiger Fingerhut	Scrophulariaceae	.6-8	12.8.05	26/8/05	30/08/05	35
34	**F 14**	Kieft	Erigeron karvinskianus	Stallone	Karwinski Feinstrahl, K. Berufkraut	Asteraceae	.5-9	12.8.05	23/8/05	30/08/05	35
35	**F 15**	Kieft	Erysimum perovskianum	Goldrush	Schötterich	Brassicaceae	.4-7	12.8.05	22/8/05	26/08/05	34
36	**F 16**	Kieft	Mimulus x hybridus	Bounty Orange	Garten Gauklerblume	Scrophulariaceae	.6-8	12.8.05	22/8/05	30/08/05	35
40	**F 17**	Kieft	Mimulus x hybridus	Bounty Red	Garten Gauklerblume	Scrophulariaceae	.6-8	12.8.05	23/8/05	30/08/05	35
37	**F 18**	Kieft	Mimulus x hybridus	Bounty Rose	Garten Gauklerblume	Scrophulariaceae	.6-8	12.8.05	23/8/05	30/08/05	35
39	**F 19**	Kieft	Mimulus x hybridus	Bounty Yellow	Garten Gauklerblume	Scrophulariaceae	.6-8	12.8.05	23/8/05	30/08/05	35
38	**F 20**	Kieft	Nepeta nervosa	Pink Cat	Aufrechte Kaschmirminze	Lamiaceae	.7-9	12.8.05	23/8/05	26/08/05	34
12	**F 21**	Kieft	Primula acaulis	Exp.Heritage Light Yellow		Primulaceae	.2-5	12.8.05	23/8/05	26/08/05	34
13	**F 22**	Kieft	Primula acaulis	EXp.Heritage White		Primulaceae	.2-5	12.8.05	30/8/05	30/08/05	35
30	**F 23**	Kieft	Primula acaulis	Heritage Creme F1		Primulaceae	.2-5	12.8.05	30/8/05	30/08/05	35
18	**F 24**	Kieft	Rosa chinensis	Angel Wings		Rosaceae	.2-5	12.8.05	2/9/05	07/09/05	36
19	**F 25**	Kieft	Salvia roemeriana	Hot Trumpets		Lamiaceae	.6-7	12.8.05	2/9/05	07/09/05	36
1	**F 26**	Kieft	Silene maritima	Icecups	Küsten Leimkraut	Caryophyllaceae	.6-7	12.8.05	26/8/05	26/08/05	34
2	**F 27**	Kieft	Sisyrinchium californicum	Yellow Stone	Kalifornisches Grasschwertel	Iridaceae	.5-7	12.8.05	26/8/05	30/08/05	35
3	**F 28**	Kieft	Veronica prostrata	Nestor	Liegender Ehrenpreis	Scophulariaceae	.5-6	12.8.05	26/8/05	30/08/05	35
4	**F 29**	Kieft	Viola cornuta	Cornetto	Hornveilchen	Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
5	**F 30**	Kieft	Viola cornuta	Microla® Blue Cream Bicolor F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
6	**F 31**	Kieft	Viola cornuta	Microla® Lavender F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
7	**F 32**	Kieft	Viola cornuta	Microla® Lemon F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
8	**F 33**	Kieft	Viola cornuta	Microla® Plum F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
9	**F 34**	Kieft	Viola cornuta	Microla® Pure Yellow F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
10	**F 35**	Kieft	Viola cornuta	Microla® White/Violet Wing F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
11	**F 36**	Kieft	Viola cornuta	Microla® Yellow/Purple Wing F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
14	**F 37**	Kieft	Viola cornuta	Skippy XL Blue/Yellow F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
15	**F 38**	Kieft	Viola cornuta	Skippy XL Deep Blue/Blotch F1		Violaceae	.6-7	12.8.05	23/8/05	26/08/05	34
17	**F 39**	Kieft	Viola cornuta	Skippy XL Purple Duet F1		Violaceae	.6-7	12.8.05	26/8/05	26/08/05	34
16	**F 40**	Kieft	Viola cornuta	Skippy XL Red-Gold F1 AAS		Violaceae	.6-7	12.8.05	26/8/05	26/08/05	34

HDC Project Self Assessment and Report Form

This form should be completed by the Project Leader and returned to the Technical Administrator hdc@hdc.org.uk by the contracted report due date.

HDC Project No	PC 247	**or**	Annual/Interim report for year(s)		
			Final report	1	
Project Leader	Andrew Fuller		Contractor	ADAS	
Title	Collaborative research programme in partnership with Saxon State Institute for Agriculture, Pillnitz, Germany for the development of 'new' ornamental plants for early season sales.				
Start date	01/09/05	End date	01/09/06	Total cost	£63,391
HDC cost	£29,924				

Scientific and Technical Objectives

Please indicate progress made in completing the technical and scientific objectives listed below, with reference to the associated milestones in the contract schedule.

		on schedule		complete
		yes	**no**	
1)	to enlarge the number of species and varieties available to growers			Yes and ongoing
2)	to provide specific advice for the cultivation of promising species / varieties,			Yes and ongoing
3)	to co-ordinate the scheduling and succession of plants after poinsettias and before pack bedding and pot bedding / patio plants,			Yes and ongoing
4)	to consider the consumers interests especially shelf life / garden performance.			Yes and ongoing
5)				
6)				
7)				
8)				

(If you have answered 'no' please give a brief explanation on a separate sheet)

Annual/Interim Reports Only

	yes	**no**
Are the remaining objectives and work plan appropriate for successful completion of the project? (If you have answered 'no', please give a brief explanation on a separate sheet)		

Commercial Benefits and Technical Deliverables

Using bullet points, describe briefly key technical findings and results likely to be of value to the industry.

- The work has indicated that a potential new market is there to be developed by UK growers, provided they have the appropriate production facilities (primarily supplementary lighting).
- The work has highlighted which plant species show most potential to fulfil the requirements of this market.
- The work has shown that scheduling of crops is possible using vernalisation, lighting and appropriate forcing temperatures. Further work is required to provide more cultural detail.
- The work has provided examples of how the plant material can be marketed to develop premium prices.

Communications/Information Dissemination

Please list all HDC and other publications, presentations, posters or other activities in which this project was featured, for the time period covered by this report.

Feature articles in HDC News:

- 2 page report in the December 2006 issue of the HDC News.

Presentations at grower events:

- A formal presentation was made to the Technical Committee of the BBPA on April 13 2006.
- A formal presentation was made at the BBPA AGM technical seminar on 8 February 2007.

Signature of project leader  **Date** 2 March 2007

HDC use only

Assessment of Completed Projects

	Yes	No
Was it the right project ?		
Was the work done well ?		
Was the work delivered on time ?		
Were the results communicated and in the right format ?		
Did the work provide value for money to the industry (= profit enhanced or at least defended if results adopted at project completion stage)?		
Did the project deliver usable results?		

Comments

Recommended action for the HDC

Annual/Interim report		**Final report**
☐	Review project	☐
☐	SOLA application required	☐
☐	Further communication work needed	☐
	Technology transfer work needed to put into commercial practice	☐
	Further research and development work needed	☐
	Project suitable for independent economic review after a few years	☐

Date to Panel:	Date to Council: