



Grower Summary

PO BOF 002a

The National Cut-flower Trials
Centre Programme for 2013 -
2017

Annual Report 2014

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GROWER SUMMARY

Headline

Garden varieties of alstroemeria perform well as a natural-season tunnel crop.

Tunnel-grown *Aster ericoides* 'Cairo' and 'Cassy' produce a first flush of flowers in early-August, and a second flush in October, using blackout covers to advance flower initiation.

Zinnia continue to show promise, mainly for sale through short, ambient-temperature supply chains such as mail order.

Tunnel-grown tracheliums impress with vigorous growth and quality stems.

Ammi, *Anethum* and *Bupleurum* show promise as direct-drilled, tunnel- and outdoor-grown fillers.

Tunnel-grown lily 'Dynamite' planted in alternative growing media – such as peat and aerobic digestate - produce flowers of equal or better quality than using standard lily peat.

Sedum and a number of other hardy perennial crops have now been planted on a commercial scale.

Background

For a long time the UK had a relatively low *per capita* consumption of cut-flowers compared with other western European countries, but between the late-1980s and early-2000s the UK's annual imports of cut-flowers rose from some £125 m to around £550 m. Perhaps surprisingly, this appeared to have resulted in no incentive for UK cut-flower growers to expand production: over the same period the value of UK-grown cut-flowers remained static at around £50 m *per annum*. This lack of enterprise was attributed to a lack of 'know-how' and a reluctance to challenge the Dutch flower export market. The Cut-flower Trials Centre project was set up in 2007, largely with funding from the HDC, and is currently funded by the HDC until the end of 2017. The immediate aim of the programme was, and remains, to provide information on the production of a wider range of cut-flowers outdoors or (taking advantage of the increased availability of low-cost Spanish tunnels) under protection. The longer-term aim is to stimulate UK grower interest in developing and commercialising novel cut-flowers and continuing to improve the quality of the more traditional products (here referred to as 'crop introduction' and 'crop improvement'). In the context of the project and its outputs the description 'novel' is interpreted very widely: it could include a

species completely new to production horticulture, or might simply indicate a crop with which UK growers are currently unfamiliar.

Summary

Crop information

A database of companies supplying seeds and planting material for cut-flower production was compiled. Research on new cut-flower crops and programmes of cut-flower trials worldwide were reviewed. Internet sources of information on cut-flower production were compiled, along with statistics of production levels and trends in the cut-flower trade. This information was used to build a programme of novel crop testing and will be available on the Centre's website <http://www.thecutflowercentre.co.uk/>

Crop introduction

Basil, cosmos, lion's ear (*Leonotis leonurus*), lupin, trachelium and zinnia were selected as novel crops for growing in demonstration plots in 2013, and carthamus, leucanthemum, ornamental pepper, physostegia and a range of seed-raised fillers in 2014. These were chosen from a large number of possible candidates on the basis of a review of the new crops and trials programmes, suggestions from growers and information from seed and young-plant suppliers. In addition, examples of new lines of some old favourites were made available for demonstration in 2014, from the 'Tiara' series of spray carnation, the 'Waltz' and 'Tango' series of delphinium and the 'Zinzi' series of gypsophila. Gentian and bleeding heart have also been identified worthy of testing in future years.

Basil (*Ocimum basilicum* cultivars)

In 2013 basil cultivars 'Dark Red Opal', 'Floral Spires Lavender', 'Floral Spires White' and 'Sweet Dani Lemon' made good growth in tunnel plantings, some having attractive, fragrant foliage with potential use as a filler. However, in tests its vase-life (VL) was poor (less than five days). Any further demonstration of basil was therefore deferred until better cultivars (such as 'Aramato' and 'Cardinal') and more information on post-harvest treatment can be obtained.

Carnation, spray, 'Tiara' series (*Dianthus caryophyllus* cultivars)

Spray carnation cultivars have previously been trialled extensively at the Centre, but the 'Tiara' series is a new type with a unique flower form that was available from HilverdaKooij in 2014 and was deemed worthy of testing.

'Tiara Coral Pink' and 'Tiara Lilac' were obtained as rooted cuttings, potted-up in week 14, pinched in week 17 and transplanted when well branched to tunnel plots in week 22. The cultivars were slow growing but threw some strong stems, of which the central bud developed first, well before the others, and consequently needed to be pinched-out to preserve the remaining spray, though this is hard to do as well as labour-intensive. The main picking dates were week 36 for 'Tiara Coral Pink' and week 37 for 'Tiara Lilac'. The plants were very susceptible to thrips damage, with white flecking appearing in the flowers, and a prophylactic spray programme would be needed. They were attractive and appreciated by growers. Stems of cultivar 'Tiara Coral Pink' were sampled for testing and had an average VL of seven days, just adequate. Damage due to thrips also detracted from their appearance in the vase.

New colours will be available from HilverdaKooij in 2015, so the current plots have been left down for 2015 and will be augmented by further varieties. VL and thrips control will need to be optimised.

Carthamus (*Carthamus tinctorius* and cultivars)

Carthamus attracts attention as an unusual 'thistle-like' filler, and cultivars 'Kinko', 'Nemo' and 'Shiro' were tested in 2014. Seed was direct-drilled into outside plots in week 25 and tunnel plots in weeks 27 and 30. The three cultivars germinated well but once budded-up - starting week 30 in outside plots - were slow to develop but eventually grew vigorously. Picking dates were condensed relative to the spread of sowing: weeks 35-36 from week 25 sowings and week 37 from week 27 sowings, while plants from the week 30 sowing were not ready by week 43 when the tunnel was de-skinned. 'Kinko' and 'Nemo' were very similar orange-flowered types, while 'Shiro' was cream-flowered. In VL testing they showed a consistent average VL of seven days, just sufficient. Brown-tipping of the bracts was evident during production and in testing and detracted from their appearance. Carthamus seems to be a suitable subject for future trials, if bract-tipping can be prevented.

Cosmos (*Cosmos bipinnatus* and cultivars)

Fifteen cultivars from the 'Razzmatazz', 'Sonata' and 'Sensation' series were demonstrated in tunnel and outside plots in 2013. They were vigorous, possibly over-vigorous and unmanageable under protection, but flowered prolifically and produced

unexpectedly robust stems with potential as a 'short-season filler' that would introduce seasonal variety to bouquets.

Having shown some promise, a further demonstration and cultivar trial was planted in 2014, using 'Double Click Cranberries', 'Fizzy Rose Picotee', 'Psyche White', 'Rubenza', 'Sensation Antiquity', 'Sensation Dazzler', 'Sensation Purity', 'Sonata Pink', 'Sonata Premium Mix' and 'Sonata White'. After direct drilling they germinated well and grew vigorously, though flowers were slow to develop and flowering was uneven. The best performer was the tunnel-grown 'Double Click' series, which even in outside plots produced stems of substantial length and weight. Stems from the last sowing (week 30), however, were short compared with earlier sowings (weeks 21, 25 and 27). Cosmos made a floriferous late-season crop through September and October, producing substantial stems. However, when samples were tested they exhibited a very short VL (one to three days).

Cosmos appears to have potential for development as a cheap, drilled outside crop, if appropriate post-harvest treatments can be established. As practised here, picking when the first bud had opened can give disappointing results, and there is a case for investigating disbudding - a reasonably quick, easy task in this species - to get a better display from the side-shoots. A further series of cosmos, 'QIS', with larger flowers on longer, stronger stems and marketed as a cut-flower type, should be investigated.

Delphinium 'Waltz' and 'Tango' series (*Delphinium elatum* cultivars)

Delphinium cultivars have previously been trialled quite extensively at the Centre, but growers and others continue to debate whether more of their potential might be realised. 'Sea Waltz', 'Sky Waltz' and 'Tango Dark Blue' are examples of new series from HilverdaKooij and were deemed worthy of including in the programme. These are tissue-cultured cultivars that produce interesting flower spikes, included following a suggestion from a grower. In 2014 plugs of the three cultivars were transplanted in week 22 into tunnel plots. They produced attractive flowers and were very productive, potentially giving three flushes in a year. A second flush had ended by late-July, and, following cutting-back, a further flush was developing before the plants were damaged by gales in late-October. They are being grown-on to a second year to assess their full potential.

The new delphinium cultivars were liked by growers because of their flower form and stem quality, however the early indications are that supermarkets would not be prepared to pay a premium price to justify the extra planting costs associated with tissue-cultured plants.

Gypsophila 'Zinzi' series (*Gypsophila paniculata* cultivars)

'Zinzi Discovery' and 'Zinzi Tyree' are brand new cultivars from HilverdaKooij that were considered worthy of inclusion in demonstration plots at the Centre in 2014. Plugs of both cultivars were transplanted to tunnel and outside plots in week 27, which was apparently too late in the season to produce a reasonable flower crops. These plants are and being grown-on to 2015 for assessment. It is claimed that the 'Zinzi' series is superior to other gypsophila on the market in terms of stem and flower quality, and the trial will allow the industry to make its own independent assessment.

Leucanthemum 'Real' series (*Leucanthemum* × *superbum* cultivars)

This crop was included to demonstrate a new range of cut-flower leucanthemum from Realflo. Pinched liners of cultivars 'Real Fancy', 'Real Fizzy' and 'Real Frilly' were transplanted in week 17 to tunnel and outside plots. As supplied, the plants had been well pinched with many breaks, and they grew away well. However, 'Real Frilly' started to bud prematurely in week 22 and then flowered on very short stems in week 25. 'Real Fancy' and 'Real Fizzy' were harvested in week 28. A second year's growth is required to see their full potential and economic viability. Further work could be undertaken to attempt to improve VL, either by changing husbandry, picking stage or post-harvest treatment.

Lion's ear (*Leonotis leonurus* and other species and cultivars)

Leonotis is a South African plant currently being introduced to cultivation, and there have been promising indications from research in Poland, Israel, Italy and elsewhere. In 2013 seed of *Leonotis* 'Staircase' were grown as plug-plants and transplanted to a tunnel. They grew vigorously, almost reaching the top of the tunnel by week 40-41 when the buds began to open, though it was by then too late to achieve a commercial harvest.

While *Leonotis* in this form would be difficult to manage, it was considered worthy of further investigation. In 2014 *Leonotis leonurus* 'Alba' and 'Staircase' and, *L. mollis* and 'Wild Dagga' were grown. All established well and grew away quickly and were

less vigorous than 'Staircase' had been in 2013. Compared with the others, *L. mollis* was relatively compact. By week 43 'Staircase' was in bud, but gales in late-October damaged the plants before any flowers opened. None of the other *Leonotis* had reached a visible bud stage. As a truly novel crop, there is much to learn about the cultural requirements of lion's ear and, although the potential for lion's ear in the UK is unknown at present, work should be extended to 2015. Earlier plantings and control of two-spotted spider mite by prophylactic applications will need to be addressed.

Lupin (*Lupinus* species and cultivars)

Due to their familiarity in the garden, lupins may not seem a likely choice as a commercial cut-flower for the UK. However, in the USA *Lupinus harvardii* (big bend bluebonnet), a native of Texas that produces attractive, tall blue flowers is being investigated for its potential as a new specialty cut-flower, two lines, 'Texas Ice' and 'Texas Sapphire', having been released. Although it was not possible to gain access to this material, perhaps because of commercial sensitivity, the popularity of lupins as garden plants means many cultivars are widely available, mainly from the 'Gallery' and 'Russell' series (*L. polyphyllus*, big leaf lupin).

In 2013 seed of 'Gallery' cultivars ('Gallery Blue', 'Pink', 'Red' and 'White') and 'Russell' cultivars ('Band of Nobles', 'Chandelier', 'Noble Maiden', 'My Castle', 'The Chantelaine', 'The Governor' and 'The Pages') were germinated in plugs and transplanted to outside and tunnel plots. After initially weak growth the plants recovered and established well. Flowering started in week 32 and they continued to produce reasonable numbers of stems over a long period. Plants of the 'Gallery' series were shorter (though not excessively so) than the 'Russell' series, though still acceptable, while the outdoor plants produced much shorter stems than those under protection. In both series the stems were of a high quality and there was a striking range of colours. They were left *in situ* for further assessment in 2014, but many plants failed to survive the winter. In combination with a short VL, the potential of 'Russell' and 'Gallery' lupins as cut-flowers appears limited.

Lupin trials should continue only if new lines and cultivars such as those mentioned above can be sourced, along with *L. densiflorus* 'Aureus' (golden lupin) and *L. x regalis* 'Morello Cherry' (probably the cultivar 'Morello' mentioned as performing well in the US Association of Specialty Cut Flowers Growers (ASCFG) trials, tall and quick-flowering) that are available from specialist suppliers.

Pepper, ornamental (*Capsicum annuum* cultivars)

Ornamental peppers proved to be successful novelties in US trials, and two cultivars were included in a demonstration at the Centre in 2014. Seed of cultivars 'Black Pearl' and 'Masquerade' were sown in 104-module trays in week 20 and transplanted to tunnel plots in weeks 25 and 27. They were slow-growing but eventually produced large, strong plants, and some fruits were visible on each cultivar by week 36 – however, thereafter they remained more or less static without growing or ripening until the tunnel was de-skinned in week 43. It is too early to speculate on their potential for UK growers, 'Black Pearl' and 'Masquerade' should be grown again in 2015, sowing and transplanting earlier. Several other attractive cultivars are available, and enquiries will be made as to whether any are earlier-maturing than 'Black Pearl' and 'Masquerade'.

Physostegia (*Physostegia virginianum* cultivars)

Physostegia was shown to be a potentially useful cut-flower in trials in the USA. A small number of cultivars is available, and one, 'Crystal', was included in an initial demonstration at the Centre in 2014. Seed were sown in 104-module trays in week 20 and transplanted to tunnel plots in week 26. The plants were rather short and late-flowering, and in VL testing stems failed on day two in the vase. The plots need to be grown-on to a second year to assess its full potential. Some other cultivars are available and could be added in 2015, particularly to see if earlier flowering and better keeping quality can be obtained.

Seed-raised fillers (various species)

There has been an increase in grower interest in producing cheap, seed-raised fillers in tunnels or outside. A range of such fillers was demonstrated in 2014: *Ammi visnaga*, *Anethum graveolens* (dill), *Anthriscus sylvestris* 'Ravenswing', *Bupleurum rotundiflorum* 'Griffithii', *Euphorbia oblongata* and *Ridolfia segetum*. Seed of all six plants were direct-drilled in outside plots (in weeks 21 and 25) and in tunnel plots (in weeks 27 and 30). The anthriscus failed to germinate and was replaced with plug-plants that were transplanted in week 25.

Ammi visnaga was slow to germinate, germination was poor, and plant growth was slow. Possibly due to the consequent wide spacings, stems were too large and branching for use as a filler in this case. Ammi was ready for picking starting weeks 33, 38 and 42 from week 21, 25 and 27 sowings, respectively, while plants from the

week 30 sowing were not ready by week 43 (when the tunnel was de-skinned). Stems had a barely acceptable VL of five days. Maybe *A. visnaga* should be drilled at a higher density to reduce plant size, or it could be grown more reliably from plugs; alternatively the more robust *A. majus* could be tested.

Anethum graveolens (dill) was quick to germinate and fast growing. Picking started in weeks 29, 32, 34 and 39 from week 21, 25, 27 and 30 sowings, respectively. The stems had a satisfactory 11 day VL, though there was substantial growth post-harvest with stems elongating by up to 90% in length. After the main stems had been picked the plants produced several secondary stems. Anethum is worth following up in 2015 to see if the excessive stem growth can be restricted.

Anthriscus sylvestris 'Ravenswing' did not germinate following direct-drilling. Replacement plug-plants established quickly, but produced only a handful of flowers. In outside plots they were seriously damaged by two-spotted spider mite. The plants have been left *in situ* to see how they perform in 2015.

Bupleurum rotundiflorum 'Griffithii' was slow to germinate and grow, appeared to bud-up early and eventually produced long, strong stems. In the tunnel crop some plants had leaf scorch, which needs to be investigated. There was renewed grower interest in bupleurum as it is easy to grow and pick, so further trials may be worthwhile, especially to investigate season extension. Regular production would require weekly sowings. Stems were sampled and had a barely acceptable VL of five days. Based on other experience such a short VL was unexpected, and it may have been due to picking at too mature a stage.

Euphorbia oblongata was very slow to germinate and grow and produced stems that were too short for cutting - about 20 cm in length. Part of the crop has been transplanted to the perennial tunnel for observations in 2015. It is possible that the latex produced from the ends of cut stems could cause skin irritation problems with workers and consumers. Before the product were recommended it would be necessary to test it in mixed vases to determine whether it had any inimical effects on other cut-flowers.

Ridolfia segetum was similar to anethum but slower germinating and growing. *Ridolfia* was ready for picking starting weeks 30, 35 and 36 from week 21, 25 and 27 sowings, respectively, while plants from the week 30 sowing were not ready for picking by week

43 when the tunnel was de-skinned. After cutting the main stem, secondary stems were produced. Anethum could be a better option.

In conclusion *Ammi majus* (or *A. visnaga*), *Anethum graveolens* and *Bupleurum rotundiflorum* appeared to be the most promising of these fillers for further trialling. *Bupleurum* grew well and the chief need is to optimise the seeding rate. For ammi and anethum poor germination, slow growth and late flowering are key problems that would merit further study, and approaches could include earlier planting dates, starting the season in a tunnel and using plug-plants. *Anthriscus sylvestris*, *Euphorbia oblongata* and *Ridolfia segetum* appeared to be less suitable.

Trachelium (*Trachelium caeruleum* cultivars)

Trachelium is not well known in the UK, although it is widely grown in the Netherlands and is produced in the USA. Several series are available, including the 'Lake Collection' which is marketed as a cut-flower trachelium, and this seemed worthy of testing. In 2013 seed of a selection of cultivars was sown in plug-trays but all failed to germinate. Subsequent discussions with growers and propagators revealed that germination had been an industry-wide issue in that year. Therefore plug-plants of 'Corine Purple' were transplanted to a tunnel plot where they grew well, producing an attractive display starting late-August. With its colour and form, trachelium could have potential for UK production and so the demonstration was repeated in 2014 using plug-plants.

Plugs of 'Corine Purple' and of the 'Lake Michigan' series ('White', 'Blue' and 'Purple') were transplanted in weeks 22 and 27. Initial growth appeared weak and budding-up occurred early, but the stems lengthened and strengthened as the plants matured, each plant producing at least one heavy lead stem and a number of marketable side-shoots. The colours were impressive. The yield of marketable stems ranged from 86/m² for 'Corine Purple' to 158/m² for 'Lake Michigan Blue'. For the lead stems, average lengths varied between 57 and 66 cm and average weights for stems trimmed to 55 cm from 23 g ('Lake Michigan White') to 32 g ('Corinne Purple'). They had an average VL of eight or nine days. Flowering continued well into September and October, though the later planting of 'Lake Michigan Purple' produced short stems, indicating that planting in week 27 was too late for natural-season flowering.

Trachelium seems to have real potential as a tunnel-grown flower for the UK, subject to testing in further years to ensure the results obtained in 2014 - in a warmer-than-usual summer - were not atypical. Growers have asked the CFC to address some specific questions earlier planting, the benefits of pinching, and cultivar comparisons covering a selection of the 'Corine', 'Lake' and 'Devotion' series including a red-flowered cultivar.

Zinnia (*Zinnia elegans* cultivars)

Unlike most species in this novel crops section, zinnia have been grown previously at the Centre (in 2007 and 2008), when the industry was enthusiastic about their wide range of bright colours. However, after picking, the hollow stems collapse and bend just below the flower-head, making them unusable, so trials were put on hold until better cultivars became available. A very different conclusion had been reached in the USA, where trials results rated zinnia as very dependable.

In 2013 seed of seven cultivars of the 'Oklahoma' series and of thirteen cultivars of the 'Benary's Giant' series were germinated in plug-trays and transplanted in weeks 22-23 to tunnel and outside plots. Shortly after planting premature buds were visible, and after pinching these out, the plants grew away vigorously. Some stems were ready for picking by mid-July, and some interesting flower colours and forms were evident. 'Benary's Giant' varieties were stronger and attracted more interest than the 'Oklahoma' series, but nevertheless the latter were considered far superior to any cultivars previously grown at the Centre. The tunnel crop was much more vigorous than the outside crop, with more and longer stems. Throughout summer, samples were taken for VL testing, but flower quality was unacceptable with a maximum of seven days in the vase, despite tests with different flower conditioners and foods. This was nevertheless a promising indication of potential, and it was suggested that they might benefit from earlier picking and treatment with flower food immediately after picking (use of an hydrating solution had been ineffective).

In 2014, a selection of cultivars was grown specifically to provide material for VL testing ('Benary Giant' series 'Bright Pink', 'Coral', 'Deep Red', 'Golden Yellow', 'Lime', 'Lilac', 'Orange', 'Purple', 'Salmon Rose', 'Scarlet', 'White' and 'Wine', and, and 'Oklahoma' series 'Carmine', 'Ivory', 'Pink', 'Salmon', 'Scarlet', and 'White'). Apart from some initial damage due to rabbits, establishment was good. Buds were visible within three or four weeks of transplanting. Plant growth was vigorous until bacterial blight (*Xanthomonas*

campestris) symptoms appeared, although after treatment, the crop again grew away vigorously and continued producing flowers in abundance until well into October, providing plenty of stems for VL testing. However, post-harvest quality was unsatisfactory, with stems failing to last to the end of the four day retail store phase. This seems to have been due to adverse effects of the cool chain resulting in early dehydration of the flowers. Chrysal consultants have suggested that there may be treatments that could avoid this damage and so VL will be examined further in 2015 utilising new plantings of 'Benary's Giant' cultivars. With current knowledge zinnia appears to be a very good candidate for ambient-temperature direct-sales such as mail order work.

Crop improvement

Alstroemeria (*Alstroemeria* cultivars): 2014 garden cultivars feasibility study

Alstroemeria are familiar as a cold glasshouse crop of high-quality, contemporary cultivars, and have not been included previously in the Centre's trials. However, the availability of Spanish tunnels raises the possibility of growing a cheap, seasonal crop. If older (garden) cultivars were used costs could be reduced as no royalties would be involved. Plug-plants of cultivars 'Apollo', 'Avanti', 'Bonanza', 'Candy', 'Dana', 'Flaming Star', 'Friendship', 'Golden Delight', 'Nina', 'Orange Supreme', 'Pink Sensation' and 'Tanya' were transplanted to beds in a tunnel (week 22) and outside (week 23). The first stems were short and were removed until marketable flowers were produced, about week 30 in the tunnel and week 33 outside. Under protection the plants were vigorous and picking peaked at the end of the season (weeks 41 to 44). Plants in outdoor plots were less vigorous, and picking was slow to begin, peaked in weeks 40 to 43 and continued to week 45. Some growers thought the stems were better than glasshouse crops. Stems of several cultivars were sampled and they had a consistent and satisfactory average VL of 12 days.

Aster, September-flowering (*Aster ericoides* cultivars): 2014 season extension trial

Aster ericoides is imported as a relatively cheap filler, usually the single-flowered 'Monte Casino' types. However, previous trials at the Centre (in 2010, 2011 and 2012) generated interest in a new range of double cultivars grown as a pinched crop for flowering in tunnels during September and October. This could potentially open up new markets, possibly as a straight line product, while growers have expressed an

interest in season extension. As *A. ericoides* is a short-day plant, floral initiation under long days can be brought forward by blacking-out the crop for part of the day. In 2013 tunnel-grown plants were used to investigate the use of blackout covers for manipulating the flowering period, the covers being left in place overnight for 13 hours per day from week 22 (stems 60 cm tall) to week 31 (large buds nearly showing colour). Flowering occurred later than expected (mainly weeks 32-33) and on stems taller than required - perhaps because of a slow start following a late spring - but their quality was superb. A second flush in weeks 45-46 was too short to be marketable. The outdoor plots ('controls') produced a single flush in weeks 37-43.

From the 2013 results, it appears the blackout treatment should have been started earlier, before the stems were 60 cm tall. In 2014, a further experiment was carried out with the blackout applied when stems were 50 cm tall (week 25). Un-rooted cuttings of cultivars 'Cairo', 'Cape Town', 'Cassy' and 'Chicago' were rooted in 104-plug trays (week 11), potted-on (week 14), pinched (week 16) and transplanted to beds in a tunnel (week 18, when the plants were already breaking). The blackout cover was applied as before, but from week 25 to week 30. Plant establishment was good in 'Cairo' and 'Cassy', with buds starting to develop in week 30 when the blackout was removed, producing high quality stems, high yield and no premature budding. However, with 'Cape Town' and 'Chicago' bud development had occurred about a month earlier, resulting in premature budding and poor quality and yield. Stems of the four cultivars were taken for testing and had an acceptable average VL of eight to nine days. After the first flush the plants were cut back almost to the ground. The natural season second flush grew-away well in all cultivars and would have made a marketable crop had it been in a glasshouse instead of a tunnel that had to be de-skinned because of an impending storm in week 43. For comparison the outdoor plots ('controls') cropped around week 42.

Eryngium (*Eryngium* cultivars): 2014 observations

Small demonstration plots of eryngium cultivars have been grown at the Centre for several years. In 2011, plantings were made of cultivars 'Arabian Dawn', 'Blue Bell', 'Deep Blue', 'Magical Blue Falls', 'Magical Cloud', 'Magical Purple Falls' and 'Marbella' outside and in tunnel beds. They were grown-on *in situ* for observations of hardiness and flowering. In 2014 samples of cultivars 'Blue Bell', 'Magical Blue', 'Magical Cloud'

and 'Marbella' were sampled for VL testing. Their VL was satisfactory at eight or nine days.

Hardy foliage (various genera): 2014 observations

A wide range of hardy foliage plants was planted in outside beds in spring 2010 and 2011. Most have become well established and there has been distinct interest from the industry: it is known that substantial commercial plantings of *Hypericum*, *Symphoricarpos* and other hardy foliage plants have been made on local nurseries. All plantings were pruned back very hard in early-March 2014 and retained to provide samples and for demonstration purposes.

Lily (*Lilium* cultivars): 2014 alternative growing media trials

Lily production in crates of soil-less media has become a significant UK line and there is now more urgency in developing peat-free growing media. Trials in 2013 indicated the potential of green compost for at least partial peat substitution for lily production, with good quality stems produced using green compost either alone or in a mixture with peat. In 2014 this work was scaled-up on a commercial site with further growing media selections that were evaluated on two crops of lily 'Dynamite'.

In trial 1 bulbs were planted in crates of 100% peat, 100% coir or 100% 'Forest Gold' (a wood-derived commercial potting compost) or mixtures of peat with coir (50:50 v/v), peat with aerobic digestate (AD) (80:20 and 60:40 v/v) or peat with re-cycled green-waste (50:50 v/v). The planted crates were moved to a tunnel in week 24. Stems were cropped in week 34 except for the peat + green-waste treatment which cropped a week later. There were only small differences in average length and weight between the growing media and these were unlikely to have been statistically significant. Growing in mixtures of peat + AD resulted in plants with better leaf colour than when growing in peat alone. Growing in peat + green-waste resulted in some stunted stems with chlorotic leaves, slightly reducing the yield of marketable stems compared with the other growing media.

In trial 2 bulbs were planted in crates of 100% peat, 100% coir or 100% green compost or mixtures of peat + coir (50:50 v/v) and peat + AD (80:20, 60:40 and 40:60 v/v) and the planted crates were moved to the tunnel in week 30. The picking period was week 41 in all treatments. As in trial 1 the differences in stem length and weight were small

and probably statistically insignificant, although in this case there were no obvious visual differences between plants in different media.

Sedum (*Sedum* cultivars): 2014 observations

Since 2010, sedum cultivars have been grown in outside beds at the Centre as a demonstration. Once established, growth was vigorous. Stem counts, length and weight were impressive and as cut-flowers they had a VL of at least seven days. In 2012 the Centre's sedum plots probably generated more attention than any of the other crops. The numerous and substantial stems could be cropped at a range of stages, from relatively tight to wide-developed, and they have potential uses in a range of bouquets as well as straight lines. Numerous samples were made available to the industry for information and promotion, and it is known that, as a result, significant commercial plantings have been made. Since the interest from growers continues and commercial plantings have been made, no further trials are planned. The plots have been retained for demonstration and sample purposes.

Stocks, column (*Matthiola incana*): 2014 fusarium control experiment

Column stocks are a mainstay of UK protected cut-flower production and they have been the subject of several of the Centre's trials. The control of fusarium is an important issue for growers. In a related trial in 2013 under project PO 005, an error was made and Octave was applied at higher than the intended rate - which produced exceptional control of fusarium, indicating perhaps that prochloraz may still be providing some level of control at label recommended rates. This trial was therefore created to try and identify active ingredients which still have some activity against the pathogen (though not providing control individually) which could be used as part of an holistic control programme.

Plug-plants of column stock 'Centum Deep Blue' were transplanted to pots of growing media inoculated with fusarium. Fungicides were applied at 2x and 4x the usual rates as a growing medium drench, using thiophanate-methyl (as 4 and 8 g Cercobin/L), prochloraz (as 4 and 8 g Octave/L), difenoconazole (as 2 and 4 ml Plover/L), boscalid + pyraclostrobin (as 3.4 and 6.8 g Signum/L) and fludioxonil + cyprodinil (as 1.6 and 3.2 g Switch/L). In addition there were controls (inoculated growing media but no fungicide treatment) and an un-inoculated comparison (no inoculum, no fungicide). The plants were grown-on in a tunnel and assessed at intervals. Judging by plant

growth and survival, both rates of Cercobin, Octave and Signum increased growth and survival and reduced the appearance of fusarium symptoms to as large extent. Treatment with Plover and Switch initially appeared successful, but the plants mostly died within a month of application. These treatments are purely experimental and cannot be used commercially, but the results suggest that better control programmes for fusarium in stocks could be developed using these fungicides including the newer family of SDHI fungicides.

Sunflower (*Helianthus annuus* cultivars): 2014 demonstration of new sunflower cultivars for protected cultivation

Since sunflowers became a fashionable cut-flower in the early-2000s they have maintained their popularity despite a number of difficulties, and significant quantities are now field-grown in the UK. Sunflowers have been included in the Centre's trials since 2010. A major requirement is to reduce the resources needed in harvesting and handling, and one approach is to switch to new dwarf cultivars. In 2014 more information was sought on the protected cultivation of new cultivars, and plots of 'Galilee Orange', 'Happy Face', 'Helios Flame', 'Lemon Party', 'Rio Carnival', 'Solar Flash', 'Stellar Sun', 'Superted', 'Tabya', 'Tall Timber' and 'Tavor Flash' and of three numbered lines (PV174, PV197 and PV199) were direct-drilled in weeks 27 and 30.

For most cultivars the germination rates were high and growth was rapid. 'Solar Flash' and 'Carnival' are actually bedding varieties and were too short for cut-flower use, but all the others gave acceptable results. Stems of a selection of cultivars were sampled for VL testing and had a consistent average VL of seven days, thereby just attaining the usual number of 'guaranteed' days, although stems of 'Helios Flame' started to bend on vase-day three.

Herbicide trials

The availability and suitability of herbicides is a particular problem in the production of 'minor crops' such as cut-flowers because the size of the market is not sufficient to cover the costs incurred in the development of information for any on-label approval. Consequently few on-label approvals are available and growers are dependent on EAMUs (Extension of Authorisation for Minor Use) and the LTAEU (Long Term Arrangements for Extension of Use). HDC Project HNS PO 192 included herbicide trials on outdoor drilled and transplanted China aster, tunnel-grown lily and outdoor drilled sweet william, and these were sited at the Centre in 2014. The results are

summarised in this report and full details will be available in the Final Report of project HNS PO 192. In addition a separate herbicide trial on outdoor drilled sweet william was carried out at a commercial nursery as part of the CFC project.

From the initial trial 'Benfluralin' looked promising, with good crop emergence and little phytotoxicity on drilled crops or transplanted asters. 'Shark' seemed a possible selective contact treatment, with China aster and sweet william recovering from initial damage. 'Defy' alone or in combination with 1 L/ha 'Stomp' appeared safe on drilled sweet william on the silty soil at this nursery. The experimental formulation HDC H22 proved highly phytotoxic to drilled crops and reduced emergence, although it would be safer in transplanted crops. All treatments used on lily and transplanted China asters were safe and had minimal effect on stem length and weight. These are all trials results, not recommendations.

Summary of the Centre's work

The Centre has continued to develop its role as an information hub and cohesive voice for the UK cut-flower industry. This has been achieved by holding a number of grower events throughout the year and Open Days to examine trials on both commercial nurseries and the main site at Rookery Farm. The project continues to produce appropriate technical literature. Several crops trialled at the Centre have attracted enough attention to be planted commercially, including sedum, hardy foliage, antirrhinum and lisianthus. In addition the Centre, in its role as a crop association, has promoted other cut-flower R&D and encouraged the development of new projects such as herbicide trials and the hydroponic production of cut-flowers.

Financial Benefits

Anecdotal evidence has indicated that a number of crops have been trialled and grown commercially as a direct result of the CFC trials programme. Examples known to be have been grown on a small-scale include the annual dianthus from Hilverda, *Aster ericoides*, carnation 'Solomio', dahlia 'Karma', phlox, scented pinks and zinnia. Others have been grown on a more commercial scale, the main ones being antirrhinum, a spot-crop of lisianthus and various hardy perennials including hypericum, salix, sedum and *Symphoricarpos* (snowberries). The following is an estimate of the area grown and farm-gate value of these products, the hardy perennials being included as single category:

Antirrhinum: amount extra grown in 2013 approximately 1.0 ha with a farm-gate value of £115,000; the value was similar in 2014.

Lisianthus: amount extra grown in 2013 approximately 0.5 ha with a farm-gate value of £70,000; in 2014 the estimate was approximately 1 ha with a farm-gate value of about £140,000.

Hardy perennials: amount extra grown in 2013 approximately 2.5 ha with a farm-gate value of £78,000 (based on an average yield figure which takes into account that these are relatively new plantings and have not yet reached their maximum yield). In 2014 the area increased to approximately 3.5 ha with a farm-gate value of about £109,000. To enable growers to undertake a basic assessment of the commercial potential of some of the most promising subjects, the following section includes some basic yields, planting density data and plant costs of the three subjects listed above, as well as of trachelium which showed great promise in the 2014 trials.

Antirrhinum: planting density around 64 plants/m² of bed, with 80 to 95% of stems being harvested (one stem produced per plant); the plant cost is approximately €40 per 1,000 plus delivery.

Lisianthus: planting density between 64 and 80 plants/m² of bed with 80 to 95% of stems being harvested (one stem produced per plant); the plant cost is approximately €53 to €78 per 1,000 (dependent on variety) plus delivery.

Hardy perennials: using *Symphoricarpos* (snowberries) as an example planting density around 1.3/m², with a yield of around 20 stems per plant from year three onwards. The plant cost of hardy perennials varies with the subject, the cheapest being sedum at less than €1 per plant, then hypericum at about €1.5 per plant, and snowberries at about €1.75 per plant. The expected life of these crops would be between 10 and 20 years.

Trachelium: planting density around 64 plants/m² of bed with at least one lead-stem harvested per plant and with some varieties in 2014 also producing one to two additional side-shoots; the plant cost is approximately €70 per 100 plus delivery.

Action Points

Tunnel-grown trachelium cultivars continue to provide impressive stems with their length, weight and colour, and should be considered as a potentially valuable and vigorous UK crop, with the proviso that they may do less well in a cool summer.

As cheap, direct-driller fillers, *Ammi majus*, *Anethum graveolens* (dill) and *Bupleurum rotundiflorum* showed promise as vigorous tunnel-raised crops and should be considered. *Anthriscus sylvestris*, *Euphorbia oblongata* and *Ridolfia segetum* seem less amenable.

Relatively cheap, garden cultivars of alstroemeria performed well and could be considered as a natural-season tunnel crop.

September-flowering tunnel-grown *Aster ericoides* cultivars 'Cairo' and 'Cassy' were amenable to seasonal extension when flower initiation was instigated using blackout covers giving 13 hour nights in June-July, a technique that could be considered to produce two flushes of flowers per year.

Alternative growing medium trials of tunnel-grown, crated lily 'Dynamite' showed that flowers of equal or better quality to those grown in standard peat could be obtained using 100% coir, 100% 'Forest Gold' (a wood-derived potting compost), peat + coir (50:50) or peat + aerobic digestate (AD) (80:20, 60:40 or 40:60), showing that growers could adopt such materials in place of peat. Mixtures of peat + green-compost (50:50) produced some variable results, but this may be due to variations in the composition of the green compost.

In trials, several other crops have shown potential for UK production in tunnels or outside, but, before recommendations are made, further investigations are required, (typically further cultivar screening, addressing cultural issues (such as planting schedules, pinching and controlling disorders) and the optimisation of post-harvest treatments). These include basil, carthamus, cosmos, leucanthemum, *Leonotis* (lion's ears), lupin, ornamental pepper, physostegia and zinnia, as well as new series of spray carnation ('Tiara'), delphinium ('Waltz' and 'Tango') and gypsophila ('Zinzi').