Grower Summary

PO BOF 002

The National Cut-Flower Trials Centre Programme for 2010-2012

Final 2012

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GROWER SUMMARY

Headlines

- Lisianthus grown in ‘Spanish tunnels’ have been identified as producing a very high quality crop in terms of stem weight and vigour, and should be considered as a new production opportunity for UK flower growers.
- Further trials have confirmed opportunities for UK growers to exploit new ‘trumpet’ cultivars of antirrhinums which now have a good colour range and acceptable spread of flowering.
- Trials with hardy foliage have clearly demonstrated that they can be produced successfully in UK conditions and some species such as Sedum have generated considerable market interest.
- Numerous column stocks trials have been undertaken which have demonstrated that the use of large block produced plants does not produce a better autumn crop, mechanical gapping up at the propagation stage does not increase the incidence of uneven flowering and that the new ‘Katz’ range has potential from autumn flowering. In addition to this a large variety trial in 2012 has helped growers and the breeder/propagator to make informed decisions about future varietal choices.
- German cultivars of China asters grown in Spanish tunnels have shown great market potential but problems with commercial crops of the ‘Krallen’ series mean that additional variety selection is required especially of the blue flowered varieties.
- Modern cultivars of double flowering *Aster ericoides* have shown significant market potential, but further work is needed to look at scheduling.
- Trials of dwarf sunflowers have demonstrated potential candidates which can be adopted by growers in the future.
- As in previous years phlox have shown considerable potential as tunnel crops in the UK.
- Initial trials in 2012 have shown the potential for the new varieties of annual Dianthus (’Breanthus’) and new spray carnations (’Star’ and ‘Solomio’) but more work is needed in 2013.

Background and expected deliverables

Outdoor cut-flower production in the UK has long consisted of the production of a limited range of mostly natural-season flowers. UK production has remained at a more-or-less static level for many years, despite a huge increase in sales of imported cut-flowers and the increase in *per capita* purchases. There is a perception that, overall, UK growers have not responded to these imports by boosting their own production. It has been suggested that this has been partly due to a shortage of appropriate cultural information, set against a bewildering range of species and unaided by conservative attitudes over what is possible under UK conditions and the apparently 'superior' level of production abroad. But production in the UK can deliver freshness without air-miles, an opportunity boosted by the current popularity of a range of summer annual flowers - often 'cottage garden' types - that can be grown to a high standard in this country either outdoors or in relatively low-cost 'Spanish tunnels'. Tunnels offer protection from weather and assist production over an expanded season, and ensure crops of high quality can be picked seven days a week irrespective of the prevailing weather.

Recognising this need to generate know-how for UK conditions, and that there was no independent trials centre for the cut-flower sector in the UK, a cut-flower group convened by the HDC in 2007 proposed setting-up a trials centre for cut-flowers, which was then established at Kirton. The 'Cut-flowers Trials Centre' was to be an industry-led, commercially oriented, independent trials site where a range of species and varieties could be assessed objectively and critically under the eyes of growers. The trials ground would include demonstration plots of newer or novel cut-flower species and variety trials of modern cultivars of established cut-flowers, as well as 'agronomic' trials to solve problems and develop the best husbandry protocols, all under typical UK climatic, cultural and economic conditions. This would reduce the sector's dependence on less satisfactory sources such as anecdotal information, promotional material from seed-houses, *ad hoc* 'look-see' trials and US texts on 'speciality flowers'. Guidance for the Centre was to be provided by a Management Group (MG) representing growers, packers and retailers, ensuring the relevance of its work to the industry. This report covers the Centre's continuing work over the years 2010 to 2012.

As well as the knowledge transfer activities that enhance the production and quality of UK-grown cut-flowers generally, an important deliverable by the Centre is the identification of potential new products for UK growers that would increase product range and provide new business opportunities.

Summary of the project and main conclusions

1. Antirrhinum (*Antirrhinum majus*) - 'trumpet' cultivars

In 2009 and 2010 the Centre grew demonstration plots of new 'trumpet' cultivars of antirrhinum that were quite distinct in flower form from the typical 'snapdragon'. They impressed the industry with their novel form, vigour and quality. In 2010 plugs of 'Ivory White', 'Red' and 'Yellow' lines from the 'Peloric' series were transplanted to plots in a tunnel in week 14. They cropped around week 22 with an average stem length of 66 cm, a six-stem bunch weight of 310 to 320 g, and longevity in standard vase life (VL) testing of up to 15 days from picking. There was a second flush of flowers around week 28 with shorter and lighter stems though still marketable. Commercialising 'trumpet' varieties requires changes in expectations and handling: their novel flower shape is not obvious unless displayed at a later stage of development than is normal for snapdragons, the colour range available at the time was limited, not enough was known of their post-harvest qualities after relatively late picking and no information was available about planting dates and season extension. All these issues were addressed in trials during 2011 and 2012.

In a further cultivar trial in 2011 plugs of 'Ivory White Peloric', 'Trumpet Pink' and 'Yellow Peloric' were transplanted in week 17 to plots in a tunnel. The first flush was in week 25. Stem weights and spike lengths varied considerably between cultivars, though all were satisfactory. 'Yellow Peloric' gave the heaviest stems and longest flower spikes. Trimmed (60 cm) stem weights in 'Ivory White Peloric' and 'Yellow Peloric' were about 50 g. A second flush produced many more stems, though these were lighter - just under 30 g for a 60 cm stem. Samples were picked in week 25 for standard VL testing: after simulated storage, transport and retail store phases, all bunches had a similar performance in the vase, and on vase-day six most of the lower buds were withering and there was slight discolouration of the stems. 50% failure occurred in all bunches on vase-day 10, bunches being terminated for browning or withering of half of the flower-heads.

To investigate seasonal extension, further trumpet antirrhinums were grown as late planted crops in tunnels in 2011. Plugs of 'Tangerine' were transplanted in week 27. Despite late planting, stem length, trimmed weight and flower spike length were about the same as the best from the earlier planting, though there was insufficient time for a second flush. Seasonal extension was further examined in 2012; plugs of the 'Apollo' series ('Cinnamon', 'Ivory', 'Ivory White', 'Purple', 'Trump' and 'Yellow') and 'Trumpet Tangerine' were planted as a late-season crop in plots in a tunnel in week 28. They were ready for cropping in weeks 34 to 35. Stem length, spike length and numbers of flowers far exceeded any minimum

supermarket specification. For comparison, plugs of traditional cultivars, 'Potomac Rose' and 'Potomac White', were transplanted to plots in a tunnel as a mid-season crop (week 22). Flowers were ready for cropping in weeks 34 to 35. They produced tall stems with long flower spikes and trimmed stem weights of about 60 g, similar to the 'Peloric' plantings.

There was positive feedback from the industry for 'trumpet' antirrhinums. Basic information was gained about varietal performance and a reasonable range of colours is now available. There was some scope for seasonal extension via planting dates, and through the second flush where the crop was planted early enough. Their VL was reasonable though not exceptional, the relatively late stage of cropping necessary to show the flowers to advantage probably being a contributory factor, since VL testing at a less mature stage in 2010 had given a VL of 15 days. Sufficient agronomic information is now available for the industry to decide about commercialising these attractive new lines.

2. *Aster ericoides* (September-flowering)

In early trials at the Centre (2007) the potential of new, mainly double-flowered cultivars of *Aster ericoides* was demonstrated as a pinched crop for September to October flowering in polythene tunnels. In 2010 a wider range of *A. ericoides* cultivars was grown: 'Blue Tail', 'Cape Town', 'Cassy', 'Chicago', 'Coldwater', 'Double Fun White', 'Flameback', 'Flamingo', 'Milka Dark' and 'Parrot'. Plugs were transplanted to plots in a tunnel in week 18 and to outdoor plots in week 20. The plants were grown both as single stems and pinched crops. The outdoor grown plants were more manageable but of poorer quality than tunnel-grown crops. Single-stem crops grew excessively tall. In tunnels, pinched plants yielded numerous strong stems ready for cropping from around week 36. The industry responded that these lines showed real potential, and numerous sample bunches were provided to potential packers and buyers. In 2011 and 2012 further cultivars were trialled as early- and late-planted crops, observations were made on the plants over-wintered in tunnels and VL was evaluated.

In 2011 an early-season crop of 'Blue Tail', 'Cape Town', 'Cassandra', 'Cassy', 'Chicago', 'Cirina Dark', 'Double Fun Blue', 'Double Fun Pink', 'Double Fun White' and 'Linda' was transplanted to plots in a tunnel in week 19. The crop was pinched two weeks later. Most cultivars produced strong plants, cropping around week 42, four to six weeks later than the equivalent plants in 2010. This had implications for crop programming since the unusually early stems in 2010 may have been due to the hot summer weather experienced then. The average stem length varied from 77 to 159 cm, stem weight from 35 to 62 g, and the number of stems cropped per plot from about 100 to just over 200, so careful varietal selection would

be necessary. Ranking the cultivars by aspects of performance 'Cassy', 'Linda' and 'Cirina Dark' produced above-average numbers of longer-than-average stems, but they were low in weight. In contrast 'Blue Tail', 'Cape Town' and 'Cassandra' produced the heaviest stems but these were relatively low in number as well as shorter.

In 2011 a late-crop was also set up with the objective of following on from a crop of column stocks. Plugs of 'Blue Tail', 'Cairo', 'Cape Town', 'Chicago' and 'Dark Mark' were pinched in week 24 and allowed to break before transplanting to plots in a tunnel in week 28. 'Cairo', 'Cape Town' and 'Chicago' cropped in week 41, but their stem lengths and weights were about half those of the early-planted crop. The other three cultivars either failed to flower or produced stems too short to crop.

Of the plots planted in a tunnel in 2010 and left down, part was pinched in week 21 and part left intact. The non-pinched, over-wintered plants grew out of control. This shows that the first flush should be cut-back to produce a late flush.

In 2012 stems of 'Blue Tail', 'Cape Town', 'Cassandra', 'Chicago', 'Cirina Dark', 'Coldwater', 'Double Fun Blue', 'Double Fun Pink', 'Double Fun White', 'Flamingo' and 'Parrot', largely from the week 19 planting, were subjected to standard VL testing. Between cultivars, VL varied from five to 11 days for the 20%-florets-dead stage, and was much longer when assessed at the 50%-florets-dead stage. In general, stems were too long, often with widely spread branches, and would require significant trimming before packing, which could be addressed through improved husbandry and varietal selection. Overall, the 'Double Fun' series were the best performers for weight and flower presentation and had a satisfactory VL. In addition, samples from ten plots, seven cultivars from the 2011 trials and three from the over-wintered crop, were picked in week 39 for VL testing. VL varied between seven and 21 days, so reaching or exceeding the current requirement for a five or seven day VL in mixed bouquets.

The trials generated increased market interest in these cultivars, but a longer cropping period was required. In 2012 a new trial involved planting a new crop both in tunnels and outdoors and cropping the plants over-wintered from 2011. The new crop consisted of plugs of 'Blue Tail', 'Capetown', 'Cassandra', 'Cassy', 'Chicago', 'Cirina Dark', 'Double Fun Blue', 'Double Fun Pink Dark', 'Double Fun White', 'Linda', 'Milka Dark', 'Milka Karmin' and 'Pretty Wendy' transplanted into plots in a tunnel and outdoors in week 25, deliberately planted later than in the previous year in an attempt to curb excessive growth. The same cultivars (less 'Milka Dark' and 'Milka Karmin') that had been planted in 2011 in a tunnel and outdoors and over-wintered were used for comparison. The results confirmed the considerable

differences between cultivars and the superior yields of second-year crops and of tunnel-growing, though yields of the new plantings may have been adversely affected by the poor summer in 2012. Stems were sampled in weeks 39 and 42 for VL testing, and, after simulated storage, transport and retail store phases, all achieved a five day VL at the consumer stage.

Numerous samples were again supplied to technologists, supermarket managers and packers, some being sent to the Netherlands. Their general quality and stem weight were considered very satisfactory and VL reasonable. Although in 2012 the main emphasis had been to find a longer cropping season, even with the range of planting combinations used it was still not possible to spread cropping over more than four weeks. The earliest picking was from the over-wintered tunnel crop, which flowered seven to 10 days earlier than the outdoor crop. In 2013 it is planned to use blackouts in an attempt to spread the season and obtain two flushes.

3. Carnation, spray (*Dianthus caryophyllus*)

'Solomio' and 'Star' are new ranges of 'novelty' spray carnations recently introduced by Hilverda Kooji. In 2012, plots were set up to assess their market potential and collect basic data for these cultivars. Rooted plugs of 'Solomio Fen', 'Solomio Sem', 'Solomio Vin' and 'Star Cherry' were delivered in week 14, when the unusually wet weather precluded immediate planting-out, so they were transplanted to 9 cm-diameter pots and transplanted to plots in a tunnel in week 18 and plots outdoors in week 21. Plants were pinched to five or six leaves three weeks after planting. In the very wet weather of 2012 the performance of the outside crop was poor and it was not worthwhile making any formal assessments. There was considerable variation in performance between the remaining cultivars: 'Sem' was the earliest to flower, with first stems picked in week 37; two weeks later 'Vin' and 'Fen' started to flower but growth was very slow and by week 45 the plants were cut-back to the ground to make way for de-skinning the tunnel, and even then many stems were not ready for picking while a number (especially in the case of 'Fen') were blind. 'Sem' produced stronger stems than 'Vin' and 'Fen', though this may have been due to poor light levels and low temperatures throughout October when the last two cultivars were being picked. Overall stem lengths were adequate at 60 to 70 cm. A selection of stems was sampled in week 39 for VL testing, and after simulated storage, transport and retail store phases, all achieved a six day VL at the consumer stage.

This new range of dianthus received positive market feedback from the industry due to its unusual flower form. It was thought these novel cultivars could be marketed at a more

developed stage of development than traditional spray carnations, being branded accordingly. Unfortunately only 'Sem' had finished flowering by the time it was necessary to de-skin the tunnel: had the crop been grown in a glasshouse the picking season could have been extended, though in better weather it would probably have been cropped two or three weeks earlier anyway. Further trials are planned for 2013.

4. China asters (*Callistephus chinensis*) - 'German' varieties

The evaluation of these striking new cultivars of large headed China aster, principally the 'Krallen' and 'Gala' series, was started at the Centre in 2007 and because of the interest shown, has continued into 2012. In 2010 a large multi-variate trial was carried out, and information from it is set out below under cultivar comparisons, comparisons of plug- and block-raised plants, effects of planting date, and use of a plant growth regulator (PGR) to control the excessive growth of the more vigorous cultivars. Demonstration plots of 26 cultivars from the 'Benary Princess', 'Matador' and 'Standby' series were also grown in 2010. In 2011 the PGR work was continued and VL testing carried out, while in 2012 alternatives to the 'Krallen' series were trialled ('Meteor' and 'Ribbon') as well as 'Bonita' which is a new "Matsumoto" type of aster.

Plugs of two 'Gala' cultivars ('Lavender' and 'Purple') and six 'Krallen' cultivars ('Chinchilla', 'Golden', 'Kameo', 'Karthauser', 'Lux' and 'Perser') were transplanted into beds in a tunnel in week 16. Mean stem lengths for the different cultivars ranged from 90 to 110 cm, with 'Gala' cultivars taller than the shorter, more variable 'Krallen' cultivars. However, the 'Gala' cultivars were conspicuously light in weight, about 20 g/stem, confirming earlier observation. In contrast the 'Krallen' cultivars were heavier, especially 'Kameo' and 'Karthauser' whose stems weighed nearly 80 g each. With the exception of 'Golden', a cultivar atypical in several respects, 'Krallen' cultivars had larger, more impressive flowers which are largely responsible for the greater stem weights. Picking dates were the same for all cultivars, except 'Golden' which was a few days later.

'Krallen' cultivars 'Chinchilla', 'Golden', 'Kameo', 'Karthauser' and 'Lux' were raised as blocks in the UK and as plug-plants in the Netherlands. They were planted in plots in a tunnel in weeks 16, 18 and 20 (plugs) and 17, 19 and 21 (blocks). The block-raised plants performed as well or better than conventional Dutch plugs. In the case of stem lengths, no consistent differences between cultivars, propagation method or planting date could be seen, though 'Chinchilla', 'Golden' and 'Lux' gave consistently long stems. Stem weight showed more distinct results, with plug-raised plants giving heavy stems from the earliest planting, decreasing later, and block-raised plants giving heavy stems from both the early and middle

plantings, with lighter stems later on. Despite their length, stems of ‘Chinchilla’, ‘Golden’ and ‘Lux’ were light in weight. Stem diameter and the number of side-shoots were reasonably consistent across the cultivar-treatment combinations, with the exception that ‘Golden’ in the three heavier sets (plugs from week 16 and blocks from weeks 17 and 19) had thicker stems and more side-shoots. Flower size varied between cultivars, but, overall, the same three heavier plantings also produced larger flowers. Within plantings, picking dates were generally similar, except that cultivar ‘Golden’ was slightly later to crop.

‘Krallen’ cultivars (‘Chinchilla’, ‘Kameo’, ‘Karthauser’, ‘Lux’, ‘Orient’ and ‘Perser’) and ‘Gala’ cultivars (‘Lavender’ and ‘Purple’) were raised as blocks in the UK for comparison with standard Dutch-raised plugs. The blocks were planted in plots in a tunnel in week 23. Mean stem lengths were reasonably consistent at about 105 cm across all cultivars, as were stem weights and diameters. In contrast to plug-raised plants there were no consistent differences between the cultivars of the two series tested. There were small (probably commercially insignificant) differences in the numbers of side-shoots per plant. Flower sizes too were consistent and all cultivars reached the picking stage together (around week 36).

To determine the earliest practical planting date for UK block-raised ‘Krallen’ in tunnels, blocks of ‘Chinchilla’, ‘Golden’, ‘Kameo’, ‘Karthauser’, ‘Lux’, ‘Orient’ and ‘Perser’’ were raised in the UK and planted in plots in a tunnel in week 16 through to 23. Except for ‘Karthauser’, which had shorter stems than the other cultivars tested, average stems lengths for the cultivars did not vary greatly and were mostly in the range 105 to 115 cm. For each cultivar there was no clear trend for stems to be longer or shorter following progressively later planting: generally stem length was satisfactory at the earliest planting date (week 16 or 17). As expected from previous results, stem weight was much more variable than stem length; with the exception of ‘Golden’, weights were heavier from the earlier plantings and fell away with later plantings, and in several cases the weights of stems from plantings in weeks 17 to 19 were double those of plantings in week 21 or later. The effects of cultivar on stem length and weight were not significant, while the effect of planting date on stem weight was significant.. Stem diameter was greater for earlier plantings of ‘Chinchilla’ and ‘Golden’ than for later plantings, but this trend was not seen in the other cultivars, and the number of side-shoots per plant varied in a similar way. For flower size too, with the exception of ‘Golden’, there was a clear trend for smaller size following progressively later planting. There were significant effects of cultivar on flower diameter and on the number of side-shoots but not on stem diameter or picking date. Flower diameter and side-shoot number and stem diameter were all significantly diminished by later planting. Essentially, these findings showed that the earlier plantings of all these cultivars produced heavier stems and larger flowers.

In order to determine the earliest practical planting date for plug-raised 'Krallen' and 'Gala' in tunnels, plugs of 'Krallen' cultivars ('Chinchilla', 'Golden', 'Kameo', 'Karthauser' and 'Lux') and 'Gala' cultivars ('Lavendar' and 'Purple') were transplanted to plots in a tunnel in weeks 16 to 22. Stem length in 'Kameo' and 'Karthauser' was shorter than average, while that of the 'Gala' cultivars was longer. There was a clear trend for the middle plantings (weeks 18 or 20) to produce longer stems. Except for the 'Gala' cultivars there was a clear trend for stem weight to decrease following progressively later plantings, an effect conspicuous in the case of 'Golden', 'Kameo', 'Karthauser' and 'Lux'. The effect of cultivar was significant on stem length and weight as was planting date on stem length and weight; the effects of planting date on numbers of side-shoots and stem diameter were not significant. In terms of flower size, there appeared to be a striking result that flower diameters were greater from the first planting (week 16) for the four cultivars that produced heavier stems from this early planting ('Golden', 'Kameo', 'Karthauser' and 'Lux'). As with the block-raised plants there was the expected later cropping from later plantings (week 20 or 22), with only minor differences between cultivars from the same planting date. However, the two 'Gala' cultivars were exceptional in that flower cropping was considerably delayed even following planting at week 18.

Since early plantings of these cultivars can produce vigourous growth and excessively long stems, an application of plant growth regulator would be useful. Plug-raised 'Krallen' cultivars 'Kameo' and 'Karthauser' and 'Gala' cultivars 'Lavender' and 'Purple' were transplanted in week 16, 18 and 20 to plots in a tunnel. The plots were treated with two rates of daminozide (as 'B-Nine SG') or were left un-treated as controls. The 'B-Nine' rates were 3 and 6 g/L, with split-dose applications made as foliar drenches to run-off on 2 June and 3 July 2010. The higher rate of product resulted in only a 10% reduction in stem length compared with un-treated controls, but only following the early planting date (week 16). Treatments to the later plantings were ineffective. There were no or only minimal effects of the treatment on the other variables measured – stem weight, stem diameter, number of side-shoots, flower diameter and picking date.

Plugs of 25 cultivars of the 'Standby', 'Benary Princess' and 'Matador' series were planted to plots in a tunnel in week 20. While these supplied an additional range of shades, the general view of the growers and buyers who examined them was that none was of the quality of the 'Krallen' series, though some might find a limited market.

In 2011 a further plant growth regulator trial was carried out. Plugs of 'Gremlin' cultivars ('Donker Paars', 'Donker Rose', 'Geel', 'Lincht Rose', 'Paarsblauw' and 'Rood' and 'Krallen' cultivars ('Birma', 'Chinchilla', 'Karthauser', 'Lux' and 'Perser') were transplanted to beds in a

tunnel in week 25. Half of each bed was treated with 'B-Nine SG' at 6 g of product per litre twice, sprayed to 'run-off', in weeks 32 and 34. With the 'Krallen' varieties applying 'B-Nine SG' gave a fairly consistent, but only 3% overall, reduction in stem length compared with the controls. In contrast the result of using 'B-Nine SG' with the 'Gremlin' varieties was unconvincing, inconsistent and resulted in an overall less than 2% reduction in length. Late in the season (week 39) samples of four cultivars – 'Bonita Scarlet', 'Chinchilla', 'Lux' and 'Perser' - were picked for standard VL testing in 2011. 'Chinchilla' gave a VL of nine days and 'Perser' and 'Lux' seven days.

Alternative large-headed annual aster cultivars were sought for a trial in 2012. These were from the 'Meteor' and 'Ribbon' series, and cultivars of the 'Bonita' series were also included as they are marketed as being complementary to 'Matsumoto', the most commonly grown spray variety. Plugs of 'Meteor Carmine Red', 'Meteor Violet Blue', 'Meteor Yellow', 'Ribbon Dark Pink', 'Ribbon Lavender', 'Ribbon Lilac Rose' and 'Ribbon Violet' were transplanted to plots in a tunnel during weeks 27 and 28, and plugs of the 'Bonita' series 'Pink', 'Blue', 'Scarlet' and 'Rose' in weeks 30 and 31 (the planting dates were much later than originally planned but they were unfortunately delayed due to supply issues with the seed-house). Despite the application of prophylactic sprays against thrips, a severe attack of Tomato Spotted Wilt Virus (TSWV) appeared early in the life of the crop. The problem was particularly serious on the 'Meteor' series but was present only at low levels in the 'Ribbon' series with virtually no symptoms on the 'Bonita' series. As a result of the late planting and subsequent poor weather, and the TSWV infection, the stems were of such poor quality that no assessments were made. None of the cultivars tested appeared to have prospects as an alternative to 'Krallen', but the trial will be repeated in 2013 using an earlier planting date and additional new varieties. The 'Bonita' range generated interest from growers of the traditional 'Matsumoto' varieties, but the range did not attain its full potential owing to late planting and poor weather. It appears likely that growers will undertake their own trials in 2013.

The series of trials with 'German asters' at the Centre showed there is potential for exploiting these vibrant cultivars in the UK. The 'Krallen' series produces a large head and strong stems of superior quality compared with the 'Benary Princess', 'Gala', 'Matador' and 'Standby' series, but there is still scope for further cultivar trials to eliminate poor or inconsistent 'Krallen' cultivars such as 'Golden', which often behaves in an atypical manner and produces weak stems of poor quality. Earlier trials showed that 'Krallen' cultivars also showed better tolerance to pests and disease. Throughout the project many samples were supplied to supermarkets, packers and local florists, some being sent to the Netherlands.

They were well received, with the ‘blue’ cultivars – ‘Karthauser’ and ‘Perser’ - identified as having probably the most market potential.

The results of the later trials on the effects of planting date confirmed and extended the earlier findings. For plug-raised plants (generalising somewhat across cultivars), later plantings led to the production of lighter stems with smaller flowers, while stem length, stem diameter and the number of side-shoots were less from either the early or the late plantings and maximal from middle plantings. In most cases later planting (in weeks 20 to 22) led to poorer quality stems, whereas early or middle plantings were satisfactory. While earlier findings had suggested that these cultivars should not be planted later then week 26, the issues of lightweight stems and smaller flowers obtained from the week 22 and 23 plantings implies that production of marketable stems from a week 26 planting seems unlikely. Subsequent commercial planting have shown that week 24 to 25 is perhaps the latest that ‘Krallen’ can be planted and an adequate crop obtained.

UK block-propagated plants performed as well or better than conventional Dutch plugs. The former gave heavier plants with larger flowers from the early and middle plantings, while the latter gave heavier stems and larger flowers only from the early planting. Block-propagated plants may be more robust than plugs, and appeared to make more consistent stems. A subsidiary trial showed that block-raised plants could simply be laid on the ground, as in AYR chrysanthemum growing; the blocks did not need to be buried in the soil, provided they were kept well watered.

Only a weak response to daminozide has been seen in these trials, and earlier and perhaps repeated applications at a higher dose appear to be needed. Once optimal treatments rates have been defined these could be used to bolster stem weight in cultivars and planting dates that need it.

The ‘Krallen’ series were grown by local producers in commercial quantities in 2009 and 2010, and ‘Karthauser’ and ‘Perser’ were in great demand by the supermarkets. Numerous VL tests were undertaken by the packer on batches being sold through the supermarkets, and their VL was found consistently to meet or exceed the guarantee of five days. Despite its great commercial potential, however, VL subsequently became an issue when a problem with petal-spotting and flower-tip browning became apparent. The cause of the disorder has unfortunately not been identified, despite extensive investigations both in the Netherlands and the UK. Losses became so severe that ‘Krallen’ is unlikely to be grown again on any large scale until the cause can be identified and rectified. Petal-spotting was less severe,

but still present, on other cultivars. In 2013 further variety trials will be undertaken to try and identify potential alternatives to 'Krallen'.

5. Dianthus, annual ('Breanthus')

'Breanthus' is a new range of annual dianthus developed by Hilverda Kooji. In 2012, plots were set up to assess their market potential and collect basic data for four of these cultivars. 'Duke Breanthus' ('Hilbreduk'), 'Earl Breanthus', 'King Breanthus' and 'Queen Breanthus' were propagated from cuttings and delivered as rooted plugs in week 14. The unusually wet weather at the time precluded immediate planting, and they were transplanted to 9 cm diameter pots and when appropriate transplanted to plots in a tunnel (week 18) and outdoors (week 21). One half of each plot was pinched (week 21 in tunnel, week 23 outside) and the other half-plot left non-pinched. In the very wet weather of 2012 the performance of the outdoor crop was very poor and it was not considered worthwhile to make any formal assessments. In the tunnel the first flush occurred in weeks 29 and 30 and the second began in week 36. Good quality stems were harvested, but the growth of the four cultivars was very different in yield, stem strength and second-flush vigour. 'Duke' gave a very heavy first flush of strong stems, but failed to produce a marketable second flush. 'Queen' produced a large number of much weaker stems in both first and second flushes. The total yield of stems for 'King' and 'Queen' were of the order expected by the propagator (>100 stems/m^2). Some stems failed to mature, probably due to the unusually poor weather and very late season. It is not yet known whether this year's behaviour of 'Duke' was typical of the cultivar, or caused by seasonal factors. 'Queen' produced substantially lighter stems and slightly shorter stems, though still sufficiently long enough for trimming to 45 cm. Compared with the non-pinched controls, pinching reduced overall stem length (except in the less vigorous 'Queen') and gave lighter stems in the otherwise vigorous 'King'.

This demonstration of 'Breanthus' received a positive market response from retailers and growers. The tight, spherical head was considered especially appealing. However, the crop was planted unavoidably late due to wet weather, and the poor season probably had a negative effect on crop performance, so the results should be interpreted cautiously and further trials are needed before these cultivars can be recommended by the Centre. In 2013 it is planned to investigate staggered planting for continuity of supply, as well as differences between pinched and non-pinched plants and between the flowers of the first and second flushes. The crop planted in 2012 will be over-wintered and (if it survives) will be assessed in more detail in 2013.

6. Lisianthus (Eustoma grandiflorum)

Cut-flowers of lisianthus have now achieved considerable popularity in the UK as a rather 'exotic' crop. Its longer growing season than many other flowers, and high heat and light requirements, restrict the number of rounds that can be accommodated in a year, but the possibility of growing a short summer 'spot' crop in Spanish tunnels was raised in discussions in 2009. In 2010 plugs were transplanted to plots in a 'Haygrove tunnel', fitted with side skirts and doors, in weeks 18, 19 and 20. Cropping started in week 30 and continued past week 34. It was acknowledged by Open Day visitors that the results were impressive, with high-quality blooms, good stem strength and no pest and disease problems. Many sample bunches were provided to packers and buyers for assessment. But it was also noted that the trial had coincided with warm, dry weather that would be very favourable for the crop, so the trial was repeated in 2011 when further cultivars were tested, planting date was investigated and growth compared in a 'closed' 'Haygrove tunnel' (fitted with side skirts and doors) and an 'open' 'Pro-Tech tunnel' (without end-doors or skirted sides). The work was extended in 2012 to study the effects of soil sterilisation and growing through black mulch.

In 2011, 30 lisianthus cultivars were included in trials. Plugs of 10 cultivars were transplanted to plots in the closed tunnel in each of weeks 18, 19 and 20, with further plugs of the 10 varieties planted in week 20 transplanted to plots in the open tunnel in week 21. Despite the wetter, cooler season of 2011, as in 2010 the plots grown in the closed tunnel produced strong, high quality stems and only inconsequential levels of pest or disease were seen, with little evidence of root diseases. In contrast, growth of the late planting in the open tunnel was weak and significant amounts of *Fusarium* were seen along with some *Pythium.* This crop was abandoned after the cover was damaged in a gale, but before this a long-established lisianthus grower visited the Centre and commented that, while the crop was not as strong and vigorous as in the closed tunnel, it was still better than his equivalent glasshouse crop, and so it would be well worth repeating in 2012 but using a slightly earlier planting date. Since the difference in pest and disease levels between the two tunnels may have related to either their different microclimates or to the means of soil sterilisation used - the closed tunnel had been treated with Basamid (dazomet) in autumn 2010 and left sheeted-down over winter, while the open tunnel had not been sterilised until spring 2011 – soil sterilisation would also need to be further investigated.

There were considerable varietal differences in cropping dates, stem lengths and trimmed weights, some cultivars evidently being more suited to cultivation in tunnels. Most cultivars planted in weeks 18 and 19 cropped in weeks 32 and 33, with the odd cultivar later. The

week 20 plantings cropped over weeks 32 to 36. Of the 28 plantings, eight failed to reach the average length of 70 cm needed for trimming to specification, but only six had a trimmed stem weight of less than 80 g each. Untrimmed stem lengths and trimmed stem weights, averaged across the cultivars, showed no clear trend with later planting, although stems from the middle planting date were shorter and lighter (each by about 10%) than either the earlier or later plantings.

Samples of cultivars 'ABC 2-3 Blue Rim', 'Dream Blue', 'Dream Lavender', Dream White', 'Mariachi Lime Green', 'Piccolo 2 Rose Pink' and 'Rosita Blue' were picked in week 32 for standard VL testing and a second batch ('ABC 2-3 Blue Rim', 'Dream Blue', 'Dream Lavender', 'Mariachi Lime Green', 'Piccolo 2 Rose Pink' and 'Piccolo 2 Deep Blue') in week 33. Amongst the different cultivars VL varied from seven to 14 days in batch one and from seven to 13 days in batch two. The main reasons for failure were flower-head damage due to *Botrytis* or drooping of the flowers and stems. The VL guarantee for straight lisianthus is usually nine days. In batch one only 'Dream White', 'Mariachi Green' and 'Piccolo Rose' achieved this, while in batch two all cultivars except 'ABC 2-3 Blue Rim' and 'Dream Lavender' did so; overall, about half the bunches picked met the nine day requirement. Lisianthus is also commonly used in mixed bouquets that are generally guaranteed for five or seven days. For the latter criterion, all bunches tested would meet the required guarantee.

A multi-factorial trial in 2012 addressed three issues:

As a result of the long growing period of lisianthus, planting densities greater than 64 plants/m^2 are used in the Netherlands to achieve commercial viability and therefore planting densities of 64, 80 or 96 plants/m^2 were tested.

To investigate the different results obtained in 2011 in the two types of tunnel – which besides their physical differences also had different dates for soil sterilisation – plantings were made into separate areas of the closed tunnel that had been sterilised with steam or Basamid in November 2011 (and then left covered with polythene over winter) or had been left un-sterilised as a control, and into an area of an open tunnel that had been steam-sterilised in November 2011.

As the possible benefits of growing lisianthus through polythene mulch had been raised in discussions by growers at the 2011 Open Day, both mulched and non-mulched plots were included in both the closed and open tunnels. The material used was a thin, micro-perforated black polythene film.

Plugs of 13 cultivars were transplanted to plots in weeks 21 (closed tunnel) or 22 (open tunnel). Cropping started in week 33. As in the previous two years, overall the stems were of exceptional quality being strong with very little disease in the closed tunnel. However, some root problems were evident in the open tunnel, though this did not result in significant crop losses in this case. The main results were:

Using a mulch did not increase stem length or weight compared with planting directly into the soil, though there was a suggestion that some cultivars were more responsive to the mulch than others.

Stem lengths were broadly consistent across the whole range of combinations of mulch or no mulch, planting rate, and soil sterilisation method. Stem weights were greatest when planted at the lowest density (64 plants/m^2), the size of this response varying between the three cultivars ('Piccolo 2 Rose Pink' was particularly responsive), but apparently irrespective of whether mulch or soil sterilisation was used.

Comparing growth in the open and closed tunnels was hampered because the plants in the open tunnel were very slow growing, many stems failing to reach maturity and flower before it was time to de-skin the tunnels in November. This was likely due to low light levels and unseasonably low temperatures in the poor summer of 2012. It was not felt that a direct comparison of crops in the two tunnels would be valid. These results and those of the 2011 trial showed that unless there is a very warm summer, the production of lisianthus can only be considered in tunnels that have a facility for their doors and sides to be closed, ensuring an adequate temperature can be maintained if the outside temperature is too low.

The last three years of trials have shown that the Centre's closed 'Haygrove tunnel' provided a superb environment for the production of high-quality, strong-stemmed lisianthus of a wide range of cultivars. Production in an open tunnel is much more risky, and was not successful during the last two years of trials. Perhaps surprisingly the 2012 trial did not show any real advantage of sterilised over non-sterilised plots, but lisianthus are known to be susceptible to so many different stem and root diseases that it would be very risky to produce a commercial crop with no soil sterilisation. As would be expected, wider spacing tends to produce stronger stems but, from the results of the 2012 trial, some cultivars seemed to respond more positively then others. Viewing the trials in 2011, representatives of a propagator and a supermarket commented that these were some of the strongest-stemmed lisianthus they had ever seen. Samples of lisianthus were supplied widely to technologists and managers of supermarkets and packers and were very enthusiastically received and as a result, some growers were being approached to produce a tunnel grown crop in 2013. With this quality in

a home-grown product, it was considered the crop could generate a good return if the supermarkets would pay a premium price for it: the main obstacle was the long time the crop is in the ground. However, the Centre's trials have demonstrated the potential of the production of the crop in closed 'Spanish tunnels' in the UK and it now up to the industry to develop it further.

7. Ornamental brassicas (*Brassica oleracea*)

For economic success ornamental brassicas need to be grown on as low-cost a basis as practical, and this is likely to involve direct-drilling as increasingly practiced in the Netherlands. In 2009 a small trial was set-up to compare the production of ornamental brassicas by direct-drilling with traditional plug planting, but, owing to extreme dry weather, germination was erratic and no meaningful results were obtained. Since ornamental brassicas appear to be very sensitive to poor soil conditions, when the trial was repeated in 2010, it was located on a commercial nursery with more a appropriate soil type. The direct-drilled crop performed well, and as a result management at this nursery intends to direct-drill most its ornamental brassicas for routine cropping in the future. Cultivar trials were also conducted in co-operation with the Centre at the same nursery in 2011.

In 2010 fifteen numbered lines of new ornamental brassicas were grown and assessed in the field and then subjected to standard VL testing. Between cultivar differences in leaf colour and form were high, as was plant height (from 20 to 53 cm). VL after a simulated storage, transport and retail period varied between 10 and 16 days. Seven of the lines were assessed as promising novelties or as alternatives to 'Crane' cultivars. Other cultivars were rejected on the basis of being 'too cabbage-like', having a tendancy to bolt, being too short, being flat-topped and collecting water on the head, not having clear colours, a tendancy to leaf browning and producing many side-shoots. Unfortunately, owing to a change of staff at the seed supplier, it was not possible to source these exact cultivars in 2011.

In 2011 ten further lines were evaluated. Seed was sown in plugs in week 22 and transplanted to field plots in week 27. Stems were harvested in week 40 and samples were subjected to VL testing. None of the varieties presented any issues over their growing, though 'Sunny Bright' consisted of mixed seed, consequently resulting in a mixture of head sizes. The overall selection produced a good range of head colour, from white to purple/pink, while many produced attractive heads, notably 'Snow Bright' with white veining in the pink/white/green leaves. Average stem length varied from 40 cm (for 'Kohju No. 2', which was considered too short) to 62 cm (for 'Dream White', possibly too tall). The percentage of stems cropped varied much between varieties – from only 5 or 10% with

‘Sunny Bright’ and ‘Kohju No. 2’, to 90% or more (in the case of tall varieties like ‘Dream White’, ‘Lake Swan’ and ‘Suruga Hatshi’). VL, after a simulated storage, transport and retail period, ranged from a satisfactory 12 days (with ‘Dream Light’, ‘Lake Swan’, ‘Sunny Bright’ and ‘Suruga Hatshi’) to 23 days (with ‘Dream White’, ‘Hakuju’ and ‘Moon Light’).

Work in the project confirmed that direct-drilling in the field was suitable for producing ornamental brassicas, and in order to reduce costs this is likely to be the way forward in field-scale production in the future. A number of new lines was identified as suitable for commercialisation, particularly ‘Dream Red’, ‘Moon Light’ and ‘Snow Bright’, and these may well be futher exploited by growers after more field-scale trials undertaken by individual producers. It was observed in these trials that plots of ornamental brassicas sometimes showed a distinct ‘edge effect’, the outside plants developing a ‘true cabbage’ appearance rather than producing a typical ornamental head, and the reasons for this need to be investigated.

8. Phlox (Phlox paniculata)

Plots of phlox cultivars ‘Icecap’, ‘Magical Dream’, ‘Magical Fragrance’, ‘Magical Surprise’, ‘Miss Fiona’, ‘Miss Marple’ and ‘Sugar Missy’ were established in 2009 in plots in a tunnel. They were grown-on mainly to provide a resource to flower packers and supermarket buyers. The crop produced blooms which were far superior to an outdoor crop. Stems were picked over the period week 27 to 31. Associated tests showed a variable but generally acceptable VL, though grower observations have indicated that, by the time of marketing, there may be a natural petal drop from the first opened florets that detracts from the appeal of the stems, an area where further cultivar selection and post-harvest studies are needed. The ‘Magical’ series showed outstanding resistance to powdery mildew, but had to be withdrawn from the trial in 2010 as a result of commercial issues.

In 2011, the plots started to crop in early-July, again giving stems of far superior quality than those on an outdoor crop. Average trimmed stem weights varied from 32 to 38 g. The number of stems cropped varied from a low 31/m^2 for ‘Sugar Missy’ to 104/m^2 for ‘Miss Fiona’. The second flush was still developing when the polythene cover had to be removed from the tunnel due to deteriorating weather. Samples of several lines were picked in week 24 for standard VL testing. ‘Sugar Missy’ had an extremely good performance with a 14 day VL, and was the only variety not to drop any flower heads during the trial. Between vase-days four and six flower drop started on all other bunches and, although the level was significant, a substantial amount of flowers still remained to open, giving the product the appearance of continuous flowering. In these cultivars VL varied between nine and 11 days.

In further VL tests in 2012 a selection of stems was sampled in weeks 34, and all achieved a seven day VL at the consumer stage.

Although no further trials work was carried out in 2012, the phlox were grown-on and, produced another crop much superior to that obtained outdoors, was used to provide high-quality samples to demonstrate to supermarket buyers. This trial has shown that phlox is a good candidate for production in 'Spanish tunnels' or cold glass and that the production of high-quality stems is possible, although there is still a potential issue with flower drop in the vase. However, as with so many other potential cut-flower lines, production needs to be developed in conjunction with the market outlets, and as such the Centre feels it cannot take these trials any further. It is now up to the industry to commercialise this crop further. It must also be pointed out that many of the varieties trialled at the Centre have been superseded by new introductions which may (or may not) be less prone to flower drop. Growers should work closely with the propagator to choose varieties that are best suited to their needs.

9. Sedum (Sedum spectabile)

In 2010 initial plots of three sedum cultivars, *Sedum spectabile* 'Brilliant', 'Herbstfreude' and 'Matrona' grew poorly, with no flowers produced in the first year. After establishment, however, their growth in the second year was vigorous. Reports of their impressive stem count, length, weight and quality as cut-flowers suggested the original planting should be extended, and in 2011 plants of cultivars 'Magical Bon Bon', 'Magical Lizzy', 'Magical Twist' and 'Mr Goodbud' were transplanted into outdoor beds in week 24. In 2012 average stem lengths across the seven cultivars ranged from 41 ('Mr Goodbud') to 81 cm ('Matrona'). After one or two years' establishment, they produced prodigious stem counts. Standard VL tests showed a long post-harvest life and the ability to crop flowers over a wide range of developmental stages.

In 2012 this demonstration generated probably more attention at the Centre than any of the other crops. The 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 been made available to the industry for information and promotion, and commercial plantings are now being made.

10. Stocks (column) (*Matthiola incana*)

Column stocks for autumn-flowering were included in the Centre's programme in 2009, when the suggested advantage of using block-raised plants (a more robust plant which would establish more easily than plugs) was tested, with transplanting in weeks 26, 28 and 33. This showed that there was no advantage using blocks over plugs, and, in any case, the plants did not flower until after the tunnel's polythene had to be removed for the winter. These trials ensured that growers did not waste time and money by using this unsuccessful technique on a commercial scale and the technique has now been totally discounted by the industry. Further trials on column stocks were carried out in 2011 (variety demonstrations and investigating issues of gapping-up and summer flower failures) and 2012 (demonstration of the non-selectable 'Katz' lines and the effects of soil sterilisation).

In producing selectable stocks, propagators use automated gapping-up to replace single-flowered plants in the plug-tray with doubles, and this process has sometimes been seen to cause apparent damage to the plants. To investigate this issue, two plots were planted in week 27 in a tunnel with 'Centrum Pink', one using selected plugs from a non-gapped-up tray, the second from a tray previously gapped-up automatically. Flower quality was assessed and compared across the two plots, and showed minimal differences in stem length and weight and spike length. Although this was only a small test, it may indicate there is no disadvantage in using automated gapping-up in this case hence enabling growers to continue to receive trays with a high number of double plants which results in reduced transport costs.

In 2011 samples of three column stocks cultivars, 'Anytime Yellow', 'Centrum Pink' and 'Figaro Lavender' were transplanted to plots in a tunnel in week 27. The main aim was to assess 'Anytime Yellow', a new line. Cut-stems were harvested in week 35. Overall stem and spike lengths were similar in the three cultivars, the main differences being in untrimmed stem weight which varied from just under 50 g with 'Anytime Yellow' to over 75 g in 'Centrum Pink'. On the basis of this small sample, 'Anytime Yellow' appeared to be of average stem length but with a long spike, and relatively light in weight. Grower trials also demonstrated the potential for 'Anytime Yellow' to supplement the current range of commercial varieties available.

Stocks are prone to failing or abnormal flower initiation when grown in summer temperatures. However, the 'Katz' series of column stocks was bred for resilience to higher temperatures, so work was planned to investigate summer cropping of 'Katz' varieties at the Centre in 2011. The plugs did not arrive at the Centre until late-August, but nevertheless

were planted in plots in a tunnel which by then had had its cover removed. The plants were in full flower in early-December, and, although battered by the weather, were of basically good quality and appeared to last well in the vase. This raised the question of whether, irrespective of its advantages as a crop in a warm summer, this series might be suitable as a late tunnel crop. Unlike many stocks varieties, the 'Katz' series is selectable for double flowers 'only with difficulty' and automated methods are not sufficiently sensitive, so it has been suggested that selection in this case is not economic. However, in the right circumstances a profitable crop might still be possible if a reasonable percentage of double flowers can be obtained when grown in a 'Spanish tunnel' or under minimally heated or unheated glass. For this reason records were kept of the numbers of double and single flowers obtained. The overall percentage of plants producing double flowers varied from 32 to 57% in different lines, or from 40 to 62% if plants with non-opening flowers were excluded (in which case about half of the eight lines yielded around 60% of doubles). Further tests would be needed to determine if the performance of the different 'Katz' lines is consistent year-on-year, and this was investigated further in 2012. Plugs of cultivars 'Cherry Blossom', 'Lavender Light', 'Pink' and 'Yellow' were transplanted to plots in a tunnel in week 28. After a weak start in which the plants lodged badly, they went on to produce some strong, long stems ready for cropping in weeks 34 and 35. The plants were severely grazed by rabbits, destroying over a third of the plants overall, with 'Cherry Blossom' and, especially, 'Lavender Light' being especially grazed.

In 2012, 48 cultivars of column stocks, representing a number of series and including many numbered lines were delivered as plugs and their performance assessed in plots of both steamed and non-steamed soil. They were transplanted to plots in both areas of a tunnel in week 21. Flowers were cropped mostly in week 30 and in general were regarded as of impressive quality. The most obvious finding was the considerable variation in stem weight and length, and spike length, between cultivars. The effects of growing in steamed or non-steamed soil depended on the variable being measured: there was a strong beneficial effect of steaming on stem weight, a smaller (and commercially irrelevant) positive effect on stem length, and no significant effect on spike length. In terms of increased stem weight, more than half of the cultivars benefited from planting into steamed soil, with a smaller group showing little or no benefit.

Although the 'Katz' cultivars started poorly, they produced some long, strong stems that provoked quite positive feedback. It is for the market to decide whether there is a place for 'Katz', considering their variability, the numbers of single flowers, and the atypical leaf form. The large cultivar trial also produced generally good quality stems and positive feedback, but

varietal selection is important since most do better on sterilised soil. This trial also demonstrated that some varieties, such as the 'Figaro' series, performed very poorly on non-steamed soil (see also HDC project PO 005). The results of this trial, along with two associated grower variety trials, were viewed by about 95% of the UK column stock growers, and will help to determine variety choice for individual nurseries in 2013 and beyond. The grower opinions of the varieties viewed at the trials will also influence the direction of the breeding work in future years.

11. Sunflowers (*Helianthus annuus*)

In 2010 sunflowers were included in the Centre's trials for the first time. Although sunflowers are already a well-established crop in the UK, their size means that harvesting and handling require significant resources. To facilitate handling, and perhaps mechanical harvesting, it was planned to investigate new dwarf cultivars as well as the use of plant growth regulators on standard cultivars. The standard cultivar 'Sunrich Orange' and a number of others including: 'Galilee Adami', 'Premier Lemon', 'Premier Light Yellow' and 'Zohar Yellow' were direct-drilled by hand to outdoor plots in weeks 24, 25 and 26. It was planned to treat the standard cultivar with growth regulator, but the extremely dry weather that followed resulted in poor germination and establishment, especially for the last two sowings. This was followed by wet, windy weather that adversely affected establishment and growth. Stem lengths were recorded at the picking stage for each cultivar from the first sowing. The average stem lengths of the standard cultivars were 151, 129 and 109 cm (for 'Galilee Adami', 'Sunrich Orange' and 'Zohar Yellow', respectively) and 48 and 45 cm for 'Premier Lemon' and 'Premier Light Yellow'. The later sowings, and the 'Premier Lemon' and 'Premier Light Yellow', failed to produce stems of marketable quality so the trial needed to be repeated. Cultivar and growth regulator trials were continued in 2011 and 2012.

In 2011 eight cultivars, some available only with code numbers, were sourced from various seed-houses and sown by hand to plots in outdoor beds in weeks 19 and 22. Percentage germination varied from 38 to 100% depending on the variety. This showed that further work is needed by breeders to ensure commercially viable germination rates. Cropping took place in weeks 32 to 35 for cultivars sown in week 19, and in weeks 33 to 35 for the sowing in week 22. For the earlier sowing 'Early Sunrise' (KB 114), 'Jua Maya' and 'Stellar Sun' (KB 105) were faster to crop than the other varieties. The cropping dates for the later sowing were more uniform, with the exception of 'Stellar Sun' (KB 105) which was again quick to crop. Flower diameters varied from 15 to 19 cm for the various cultivars. The flowers of 'Jua Maya' were relatively small from both sowings. For most, but not all, cultivar stem lengths were greater from the later sowing, but this was not always accompanied by increased stem

weight (there appearing to be no obvious relationship between the two). 'Happy Face' (KB 116) was the most dwarf cultivar trialled, from both sowings, and produced a relatively high stem weight. Bunches of cultivars 'Galilee', 'Happy Face', 'KB105', 'Sunrich' and 'Dafna' were cropped in week 35 and subjected to standard VL testing. The outstanding result was the quality and long VL of cultivar 'Dafna'.

Seed of the standard sunflower 'Sunrich Orange' were sown by hand in an outdoor bed in each of weeks 19, 22 and 26. The plant growth regulator 'B-Nine SG' (daminozide) was applied as a foliar spray to 'run-off' on part of each bed, using a rate of 6 g product/L, in week 32 and again in week 33. As it was visually obvious that the treatment had had no effect on plant height, no measurements were made.

Three novel cultivars were evaluated in 2012: 'Vincent's Fresh', 'Vincent's Choice' and a new line, VV10-4. They were direct-sown by hand into plots outdoors in week 23 and plots in a tunnel in week 31. In the tunnel 'Vincent's Choice' averaged 1.9 m-tall stems weighing 0.2 kg, with a flower diameter of nearly 18 cm, while 'Vincent's Fresh' was shorter and lighter (1.6 m, 0.15 kg), with a similar head size. 'VV 10-4' was only a little shorter than 'Vincent's Fresh', but had much lighter stems (0.11 kg) and smaller heads (12 cm) and therefore showed potential as a more cost-effective product. The very wet weather this year was not favourable to outdoor sunflowers, resulting in a combination of poor germination and damage to the petals from wind and rain. However, with an average height of 1.1 m for 'Vincent's Choice', 1.2 m for 'Vincent's Fresh' and 0.75 cm for 'VV 10-4', for stems cropped in week 43 it would appear as if the new coded variety does have potential as a truly dwarf variety of good appearance and manageable dimensions.

The variety trials gave the opportunity for growers to view a wide range of the recent sunflower introductions and compare this with their own trials of some of the same varieties. It is for growers themselves to determine the most appropriate variety for their situation, but 'Dafna' looked very promising from the 2011 trials, with VV 10-4 from the 2012 trial showing potential as a truly dwarf variety for both outdoor and protected production.

12. Sweet peas (*Lathryus odoratus*)

Recurring expressions of interest in developing a low-input system of sweet pea production led to trials at the Centre in 2011. A metal 'A' frame with netting was erected along the length of a tunnel. Seeds were germinated in small, individual pots and transplanted in rows along either side of the framework in week 22 at each of 30 or 50 cm spacings. The 50 cm spaced plants were pinched once, while the 30 cm spaced plants were not pinched. The first stems were picked in mid-July, cropping continuing for an extended period. The initial results were very encouraging, with a large number of long, high quality stems being produced from both growing formats. The average length of stems approached 30 cm, with slightly longer stems from the 50 cm, pinched plots. However, floret numbers were consistently low, with 3.3 to 3.8 florets per stem. Between 1,000 and 2,000 stems were obtained for each 5 m-long plot. Bunches of 'Valerie Harrod' and 'Gwendoline' were picked in week 34 for standard VL testing, and all bunches had a similar performance irrespective. Stems started to fail from vase-day two onwards, and all bunches showed 50% stem failure on vase-day five due to bud drop.

This investigation was originally instigated as a result of a request from a supermarket to develop a lower specification, and therefore a lower price point, for the product. The trial produced a large number of good quality stems, but the average floret count was only three or four and this was not received favourably by the supermarkets. As a result, the trial was not repeated in 2012: it is likely that sweet peas will remain a small-scale, high-value niche product.

13. Preliminary assessments

<u>Amaranthus (Amaranthus caudatus)</u>

After a specific request from a grower, a small selection of amaranthus cultivars was grown in 2011 to assess their potential as a cut-flower. Plugs of 'Caudatus Red', 'Green Thumb', 'Oeschberg', 'Pygmy Torch' and 'Red Cathedral' were transplanted to plots in a tunnel in week 21. Cropping started in week 30. The length and form of the inflorescences varied considerably, though all were vigorous. The smaller-flowered types were thought to have potential as cut-flowers for supermarket sales, whereas the larger types have scope for a specialist grower, for example, for architectural displays in larger settings. From comments received from the industry, it would be useful to look at an earlier cropping stage that might be more appropriate to develop their commercial potential. It was hoped to continue with a

variety demonstration in 2012 and use the material to investigate cropping stages and VL, but there were difficulties in obtaining the plugs and the trial could not be repeated.

Campanula (*Campanula* species)

Campanula was considered by the MG to have some potential, and an initial assessment was carried out in 2012. Three cultivars, 'Champion Lavender', 'Champion Pink' and a numbered line 135 5005, were delivered as plugs and transplanted to plots in a tunnel in week 22. All varieties cropped in week 31, producing stem counts of 98, 96 and 99 stems/plot, respectively. There was a positive response from growers, and samples were taken to show interested parties and for VL testing. This has resulted in a renewed interest in the crop amongst some growers.

Celosia (Celosia cristata)

Although celosia has been tried as a cut-flower in the UK before, there does not seem to be a demand at the present time. Plugs of celosia cultivars 'Bombay Flora' and 'Bombay Fire' were planted in plots in a tunnel in week 23. This gave a very good quality product creating a good market reaction, though there would be only limited scope to sell any volume.

Dahlia (*Dahlia hybrida*) - 'Karma' series

More than one member of the MG has confirmed the supermarkets' interest in sourcing dahlias as a cut-flower, but this is currently being resisted since VL issues are still unresolved. Dahlias are generally considered to have a poor VL, but the 'Karma' series was developed to deal with this shortcoming. In 2009 a demonstration of 18 'Karma' cultivars was grown. Cuttings were planted in week 28 in both outdoor beds and in plots in a tunnel, the cultivars being 'Amanda', 'Bon Bini', 'Choc', 'Corona', 'Fiesta', 'Irene', 'Lagoon', 'Maarten de Zwaan', 'Naomi', 'Pink Corona', 'Prospero', 'Red Corona', 'Royal', 'Sangria', 'Serena', 'Thalia', 'Ventura' and 'Ying Yang'. Although the crops grew vigorously, especially under protection, and the blooms were eye-catching, the results of VL tests were disappointing. The flowers failed to reach the minimum of 11 days VL considered necessary to be a commercial proposition, while the vase-water became highly contaminated. Despite these disappointing results, productivity and flower quality were so impressive that the plants were maintained as a demonstration, and there was a proposal to develop an HDC-funded project to examine the post-harvest qualities of dahlia blooms on a more strategic level.

Delphinium (Delphinium elatum)

Although delphinium was trialled in the early work of the Centre (in 2007 and 2008), some new cultivars from Hilverda Kooij suggested a fresh demonstration would be worthwhile. In 2012 plugs of cultivars 'Tango Dark Blue', 'Trick', 'Trick Pink', 'Sky Waltz' and 'Yellow Trick' were planted in plots in a tunnel and outdoors in week 25. This year the weather proved unsuitable for producing stems of any quality.

Eryngium (*Eryngium* species)

Responding to a grower's request, in 2011 a small selection of new eryngium cultivars was grown to assess the varieties available and their potential as a crop in the UK. Plugs of cultivars 'Arabian Dawn', 'Blue Bell', 'Deep Blue', 'Magical Blue Falls', 'Magical Cloud', 'Magical Purple Falls' and 'Marbella' were transplanted into plots in a tunnel and outside in week 32. Few flowers were produced in 2011. Although marketable stems were produced in 2012, owing to plant losses as result of the cold weather and the effect of the wet summer and autumn of 2012, it was not possible to record any meaningful yields. However, the samples sent to the packers and supermarkets generated considerable interest in this crop and as a result a new planting will be made in 2013. Stems were sampled in week 34 for VL testing (by Butters Group Ltd). After simulated storage, transport and retail store phases, all achieved a seven day VL with the consumer.

Hardy foliage

A wide range of hardy foliage plants was planted in outdoor plots in the spring of 2010 and 2011:

- *Calicarpa bodiniera* 'Profusion'
- *Cornus alba* 'Flaviramea'
- *C. alba* 'Kesselringil'
- *C. alba* 'Sibirica'
- *Corylus avellana* 'Contorta'
- *Cotinus* 'Magical Green Fountain'
- C. 'Royal Purple'
- *Hedera helix* 'Arborescens'
- *Hypericum inodorum* 'Magical Green Fall'
- *H. inodorum* 'Magical Tropical Fall'
- *H. inodorum* 'Magical White Fall'
- *Philadelphus* 'Snowbelle'

- *Photinia* ‘Purple Peter’
- *P.* ‘Red Robin’
- *Quercus palustris*
- *Q. rubra*
- *Salix alba* ‘Darts Snake’
- *S.* ‘Caradoc’
- *S*. *udensis* ‘Sekka’
- *Symphoricarpos* ‘Bright Fantasy’
- *S.* ‘Charm Fantasy’
- *S.* ‘Magical ‘Avalanche
- *S*. ‘Magical ‘Pride’
- *Viburnum opulus* ‘Compactum’
- *V. opulus* ‘Roseum’
- *V. tinus*
- *V. tinus* ‘Red Spirit’

Most subjects have established well and the number of marketable stems will be assessed in 2013. Commercial plantings of foliage subjects are now taking place as a result of these demonstration plots.

Rudbeckia (Rudbeckia hirta)

Rudbeckia is another potential cut-flower crop, and its inclusion in the programme of the Centre was suggested by a supermarket representative. Initial demonstrations with seed-raised annuals were carried out in 2011 and 2012. In 2011, cultivars ‘Hirta Green Eye’ and ‘Hirta My Joy’ were transplanted into plots in a tunnel in week 21. Although the flowers were attractive, the stems were too vigorous and unruly to be considered practical for commercial use. More robust perennial varieties were tested in 2012. These were cultivars ‘Goldquelle’ and ‘Herbstsonne’ supplied as 7 cm pots and planted in plots in a tunnel in week 25. While the crop did show some market potential, many of the stems were quite weak and as is the case with most perennial crops, their true potential is likely to show up in the second year and beyond.

Financial benefits

The project has identified a number of crops such as tunnel-grown lisianthus, 'trumpet' antirrhinum, hardy foliage and sedum as having potential for UK production. Other novel crops have also been developed and are at a stage where they could be tested on a small commercial scale. Two or three new products would help to maintain a significant number of larger or medium-sized businesses. Now that the CFC is developing a clear market potential for 'new' crops, it is proposed that the preparation of basic costings will be an integral part of its remit in the future. The basic costings will include as much information as possible including planting costs, yield, basic production costs etc. but clearly it will be difficult to provide accurate labour figures owing to the issue of scaling up small scale trial plots to a realistic commercial situation. This information will be disseminated to industry in the form of technical bulletins available on the CFC website.

Action points for growers

Growers looking for new opportunities might consider the case for growing new cultivars of 'trumpet' antirrhinums, lisianthus and annual dianthus as tunnel crops, and new cultivars of dwarf sunflowers, hardy foliage and ornamental brassicas as field crops.

Antirrinum

The planting density of 'trumpet' antirrhinums should be around 64 plants/m^2. Early plantings in week 14 to 17 produce two flower flushes in early to late summer and a week 27 planting produces an early autumn crop demonstrating that continuity of cropping is possible with these new varieties. Very few pest and disease problems were experienced in the trials but aphids can be a problem, so application of a suitable insecticide may be required. Pollination by bees can also be in issue in some situations but this can be overcome by netting of the doors and vents.

Aster ericodes

The new double varieties of *Aster ericoides* can be planted both indoors and outdoors from a planting date of mid-April to early May. A planting density of 16 plants/m^2 should be used. The crop is usually then pinched two to three weeks later. If grown under protection the crop needs to be cut back in mid to late May otherwise the stems become unmanageable by the time of flowering. Powdery mildew is a major problem with *Aster ericoides* and a regular fungicide spray programme needs to be adhered to.

‘Breanthus’ annual dianthus

Planting in week 18 was successful with this crop, pinching can be undertaken which will produce slightly shorter and lighter stems. Flowering from this planting date will occur around week 30 with a second flush in week 36, although there is considerable variation in the performance of the different cultivars.

China aster

Young plants can be bought in grown in plugs or peat blocks with the blocks tending to produce a heavier crop from later plantings. The optimum planting density is 64 plants/m^2 and they can be planted under protection from about week 16 up to about week 25. (Earlier plantings may result in excessive growth whereas the later plantings may be too short if the autumn weather is not favourable to good growth).

Whole plants are harvested and made into bunches of between three and five stems. The central flower bud can be removed to enhance vase life but this will result in a significance reduction in weight.

Column stocks

In terms of starting material there is no advantage in using plants produced in peat blocks as opposed to plugs. Using product which has been gapped up provides trays with a higher number of double plants which results in reduced transport costs. The ‘Anytime’ series has potential for later plantings; whilst the new range of ‘Katz’ cultivars may have potential for autumn production in Spanish tunnels. Soil steaming is important with the performance of many varieties not least the ‘Aida’ and’ Figaro’ series.

Lisianthus

This crop can be successfully produced in a closed Spanish tunnel. Planting time should be between weeks 18 to 21 producing a marketable crop between weeks 32 and 36. The planting density can range from 64 to 86 plants/m^2. The lower density will yield slightly stronger stems. As the crop is prone to a number of root and stem diseases it should be produced in sterilised soil. Care needs to be taken to ensure that the humidity level does not build up inside production tunnels as this will provide a favourable environment for the development of downy mildew.

Ornamental brassicas

Direct-sowing of ornamental brassica is a possible way to reduce production costs. A number of new cultivars show promise for commercialisation including: 'Dream Red', 'Moon Light' and 'Snow Bright'.

Phlox

Powdery mildew is a serious problem on this crop and a regular prophylactic fungicide spray programme needs to be maintained through the life of the crop. The crop can be produced in polythene tunnels or under cold glass; in the latter structure a second flower flush may occur. Growers should liaise with the propagators to ensure that they are planting the best varieties currently available to minimise flower drop during shelf life.

Sedum

The main planting period is spring or autumn at a density of 10 to 12 plants/m^2 in 1m wide beds. Cropping can be expected from the second year onwards. Harvesting can occur when the heads are green, through flower bud stage and ultimately when in full flower. Vase life was shown to be very good at all stages of cropping.

'Solomio' and 'Star' spray carnations

Exact planting dates and production structures still need to be verified for the cultivars examined. The 'Star' series is very attractive to rabbits and precautions need to be taken to protect the crop from rabbit feeding.

Sunflowers

Cropping times can be staggered by sowing from weeks 19 to 26 outdoors and week 31 in a Spanish tunnel (cropping times ranged from week 32 to 35 outdoors and week 44 in the tunnel). The variety 'Dafna' had an outstanding vase life.