



Grower Summary

POBOF 002a

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

Annual 2017

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Project number: PO/BOF 002a

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Report: Fourth Annual Report (2016)

Previous report: First Annual Report (2013)
Second Annual Report (2014)
Third Annual Report (2015)

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(or expected completion date):** 31 December 2017

Grower Summary

Headline

Scabious showed great promise for cut-flower production in the UK when grown in both tunnels and outdoor. The 'Scoop' series has an attractive range of colours, high yields, good vase-life and potential for use in mixed bouquets.

Craspedia is an unusual product with high yields of yellow, globe-shaped flowers on long, strong stems. 'Paintball Globe' and 'Ellisse' showed good potential for sales as fresh or dried flowers and as a filler in bouquets.

Gomphrena is prolific, with red, pink and white flower spikes and the possibility of 'once-over' cropping. It showed good potential as a filler.

A range of ornamental grasses generated much interest for use in fashionable mixed bouquets. *Panicum elegans* 'Sprinkles' and *Stipa capillata* 'Lace Veil' particularly elicited positive comments.

Background

For a long time the UK has 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 £125m to around £550m. Over the same period the value of UK-grown cut-flowers remained static at around £50m *per annum*. This shortage of enterprise was attributed to (1) a lack of 'know-how' and (2) a reluctance to compete against the Dutch flower export market. The National Cut Flower Centre (CFC) project was set up in 2007, largely with funding from the HDC (now AHDB Horticulture), and is currently funded by AHDB Horticulture until the end of 2017. The immediate aim of the project is to provide information on producing a wider range of cut flowers outdoors and, taking advantage of the increased availability of low-cost Spanish tunnels, under protection ('*crop information*'). The longer-term aim is to stimulate the UK grower's interest in developing and commercialising novel cut flowers ('*crop introduction*') while continuing to improve the quality of the more traditional products ('*crop improvement*'). In the context of the project the term 'novel cut flowers' is interpreted widely: it could include a species completely new to production horticulture, or might simply indicate a crop or cultivar with which UK growers or customers are unfamiliar at the present time.

Summary of the project and main conclusions

The Centre continues to develop its role as an information hub and cohesive voice for the UK cut flower industry, as demonstrated by the high turnouts at the Open Days. The CFC has been successful in developing the core strategic theme of the project by facilitating and hosting AHDB Horticulture-funded herbicide trials, undertaking trials looking at alternative growing media for boxed lilies (partially funded by Bulrush Horticulture), developing a standalone AHDB Horticulture-funded trial to investigate the hydroponic production of cut flowers and carrying out a review and industry survey of flower spotting issues in cut sunflowers.

Several crops trialled at the Centre have attracted enough attention for commercial production to commence, including antirrhinum, bupleurum, lisianthus, sedum and woody foliage. Many subjects from the most recent trials are generating market interest too: these include 'alternative' varieties of ornamental brassicas, craspedia, direct-seeded herbaceous fillers, gomphrena, ornamental grasses, scabious, seasonal alstroemeria and trachleium.

Crop information

Trials are underpinned by the reports produced by the CFC including:

Database of firms supplying seeds and planting material for cut flower production (updated in 2015);

Report on research on new cut-flower crops and cut flower trials programmes worldwide (updated in 2015 and 2016 and on-going);

Report on the statistics of production and trends in the cut flower trade worldwide (published in 2015, updating on-going).

This information would also be of value to growers planning their own new product development and documents are available from the AHDB Horticulture and CFC websites.

Crop improvement

Alstroemeria – garden cultivars (Alstromeria cultivars)

Commercial alstroemeria cut flower production involves contemporary, high-quality and expensive cultivars grown as glasshouse crops. The availability of Spanish tunnels, however, raises the possibility of growing an inexpensive, seasonal crop of the older, garden cultivars, to which no royalties are attached. A feasibility trial was set up over 2014–2016 with a selection of cultivars ('Apollo', 'Avanti', 'Bonanza', 'Candy', 'Dana', 'Flaming Star', 'Friendship', 'Golden Delight', 'Nina', 'Orange Supreme', 'Pink Sensation' and 'Tanya') grown in a Spanish tunnel or outdoor beds.

Marketable flowers were produced in the tunnel starting week 31 (2014), week 23 (2015) and week 22 (2016), and picking continued until weeks 41–44, when all recording was brought to an end to allow the tunnels to be de-skinned for winter. Under protection the plants were very vigorous, producing strong stems that some growers considered better than those from a typical glasshouse crop. The outdoor crop, over the three years, produced marketable stems from weeks 33, 26 and 26, respectively, but were less vigorous with fewer flowers compared with the protected crop. In the year of planting there was a slow build-up in flower production, with most picking in the second half of the season, while in the second and third years there was a shift to earlier picking with a rapid build-up to the main picking period. With this combination of twelve cultivars and tunnel and outdoor plots the supply of flowers was reasonably consistent and occurred over a long, five month period, though few or no flowers were available in some weeks each year. The consistency of supply might be improved by growing new plantings alongside older ones, or by making a small number of sequential plantings.

Overall, yields in the tunnel were more than double those for outdoor plots, and annual production increased over the three years of the trial. In round terms, tunnel-grown crops produced about twice the yield of outdoor beds in 2014 and about three-times the yield in 2015, falling back to less than double in 2016. The overall yields of individual cultivars varied markedly. In the tunnel or outdoors, the productivity of half of the cultivars increased annually, while most of the rest peaked in the second year. Overall, ‘Nina’ was the highest yielder, consistent in the tunnel and outdoors and across the three years. ‘Dana’, ‘Flaming Star’, ‘Friendship’ and ‘Tanya’ were among the higher producers too, with ‘Dana’ doing particularly well as a first-year crop and in outdoor beds and ‘Friendship’ doing well in the tunnel. Overall, ‘Apollo’, ‘Bonanza’, ‘Golden Delight’ and ‘Orange Supreme’ were poorer performers.

A selection of cultivars was sampled for vase-life (VL) testing, giving a satisfactory average VL of 12 days¹. It appeared important to allow the flowers to show good colour before picking as this made the product more attractive and did not appear to detract from its VL. Growing non-PBR cultivars in tunnels appeared to have strong potential. And, despite their lower quality and yields, growing alstroemeria in the open may still have a place for small growers.

Brassica, ornamental (Brassica oleracea cultivars)

Consumer and grower interest in ornamental brassicas continues to be high, despite uncertainties about some aspects of their husbandry and which cultivars to grow. Trials in

¹ All vase-lives in this report refer to the length of the consumer (vase) phase itself, which follows the simulated storage, transport and retail phases that total a further 3–4 days.

2015 and 2016 addressed the choice of cultivars for the high-quality tunnel crop, growing some newer cultivars alongside the more familiar 'Crane' series. In 2015 the cultivars grown were 'Agathana', 'Anthonia', 'Bogdana', 'Bright Wine', 'Condor Early White', 'Condor Pure White', 'Crane Bicolour', 'Crane Queen', 'Crane Pink', 'Crane Red', 'Crane Rose', 'Crane White', 'First Lady', 'Galina', 'Katya', 'Ksenia', 'Kysia', 'Olga', 'Svetlana', 'Varvara' and 'Vera'. Only 'Kysia' failed to colour-up. Compared with the trial averages, 'Bright Wine' and 'Olga' produced heavier stems, 'Bogdana', 'Crane Queen' and 'Katya' lighter stems, 'Anthonia' larger heads and 'Agathana', 'Crane White', 'Olga' and 'Varvara' smaller heads. With high-quality heads and VL of 10–17 days, a number of the less familiar cultivars showed real promise and generated market interest exceeding that of the more familiar 'Crane' series.

There was an impression that many growers and pack-houses would prefer to stay with the well-trying 'Crane' series until more experience has been obtained with alternative cultivars. To this end plots of 'Crane' cultivars ('Crane King', 'Crane Pink', 'Crane Queen' and 'Crane White') and others ('Agathana', 'Anthonia', 'Bogdana', 'Condor Pure White', 'First Lady', 'Ksenia', 'Kysia', 'Olga' and 'Vera') were trialled in tunnels in 2016. 'Kysia' again failed to colour-up. All cultivars produced heads of high quality, though some (especially those with dissected leaves) failed to give the high marketable yields of others. In vase-life testing all cultivars reached at least the guaranteed life of 5 days.

China aster (Callistephus chinensis cultivars)

In the last decade china asters (annual asters) have become an important seasonal outdoor summer cut flower in the UK, dominated by the 'Matsumoto' spray type grown in quantities of about 9 million stems annually. Work at CFC up to 2013 opened up a new market for the alternative large headed, 'bloom'-type, culminating in the 'Krallen' series with their vibrantly coloured flowers. Generating distinct interest from growers, there appeared to be potential for commercialising 'Krallen' in the UK. However, post-harvest quality became an issue when petal-spotting and browning of the flower-tip became apparent. Since no cause or remedy was found, CFC trials looked towards finding alternative cultivars. Between 2010 and 2015 trials were conducted with the 'Beautiful Day', 'Benary Princess', 'Harlequin', 'Matador', 'Jewel', 'Lady Coral', 'Matador', 'Meteor' and 'Standby' series. Many of the cultivars tested had stem and flower attributes with promise for growing in the UK, but none was considered likely to become an alternative for 'Krallen'.

In 2016 the Centre carried out a demonstration of a further series of spray-asters, 'Julie', and two coded bloom-type asters. Recently becoming available from Miyoshi, these have a different colour range and a claim for earliness. The demonstration was used as a source of

material for showing to packers and supermarkets and it was reported that samples were well received by one supermarket, but that they were similar in timing and quality to some other cultivars being grown in the industry. In favour of the 'Julie' series, some different colours and fresh seed stocks were appreciated. Grown under tunnels the plants were larger but paler than outdoor-grown plants.

Column stocks (*Matthiola incana* cultivars)

Column stocks are a mainstay of UK protected cut flower production. Variety trials carried out at the Centre in 2012 and 2013 added to the industry's interest in the 'Katz' series as a late-summer crop. Although their stem quality was poorer in 2013 than in 2012, possibly due to higher than usual summer temperatures in the second year, it still excelled that of comparable plants grown in a commercial glasshouse trial. Growing the crops in both steamed and non-steamed soil showed a strongly beneficial effect of steaming on stem weight (but not on stem length). In the commercial glasshouse trial the plants were also used to evaluate susceptibility to fusarium wilt (the glasshouse had a history of the disease). Resilient and productive cultivars included 'Avalanche White', 'Fantasy Red', 'Fantasy Red Imp', 'Phantom Cream Imp', 'Phantom Red', cultivars of the 'Anytime' and 'Katz' series and 'Figaro Lavender'; these properties were not shared by cultivars in the 'Opera' series.

At the same time there were increasing concerns about the poor establishment, growth and flower uniformity in column stocks. This did not appear to be due to any single factor, but to a combination of issues such as the poor performance of some varieties on un-steamed soil and the presence of *Pythium* or *Fusarium*. Separate HDC projects were carried out in 2013 to survey cultural practices, investigate the role of *Pythium* and *Fusarium*, and consider the possibility of remedial effects from soil amendments (projects PO 005 and 005a). In 2014 the control by fungicides of fusarium wilt was investigated at CFC: Cercobin WG, Octave and Signum were options for control, while Plover and Switch appeared successful initially, but most plants subsequently died.

In 2016 a new demonstration of column stocks was set up to show the commercial varieties currently available from the only two suppliers to the UK, Florensis and Noordam (subsequently Noordam decided to withdraw from this market after 2016), and to investigate the effects of steam-sterilisation. Cultivars from the 'Aida', 'Anytime', 'Centum', 'Figaro', 'Jordyn', 'Mathilda', 'Milla' and 'Opera' series were included. Replicate plots were planted in steam-sterilised and untreated areas of the tunnel. The plugs established well but were stressed by hot weather in mid-July. As was known to be the case with late-planted commercial crops this year, the trial suffered from uneven flowering, the 'Mila' cultivars being

the worse of all: only 'Mila Apricot' produced a reasonable number of marketable stems ('Mila White' produced a late flush at the end of August). Downy mildew, diamond-backed moth and sclerotinia were further problems, necessitating rouging of the crop and an intensive spray programme. As expected, performance in the non-steamed soil was poorer than in the steamed area, but the difference was less marked than had been seen in previous trials. With the weather-related problems that occurred in 2016, no formal records of the trial were taken, but it gave growers an opportunity to view the recent new introductions, such as 'Mathilda' and 'Mila', side-by-side with the older, longer established varieties.

Lily (Lilium cultivars)

Lilies remain hugely popular with UK customers and UK production of cut flowers from imported bulbs has been very successful. To avoid the soil-borne pathogens common in glasshouse soil, lilies are generally grown in crates of growing media. For many years peat has been used as the sole or basic growing medium, so there is obviously interest from growers to discover suitable alternatives or diluents for peat, and trials of alternative substrates have been carried out by the CFC since 2013. In the first trial a selection of newer cultivars was assessed for the suitability of a green-waste substrate in two separate trials. Bulbs were grown in 100% grower's peat-based medium, 100% green-waste or a 50:50 v/v mixture. Stems were longest when grown in the grower's peat-based medium, shorter in the mixture and shortest in the green-waste, though the tallest and shortest average length for a cultivar varied by only 20 to 25cm. There were no differences in bud count between growing media. Apart from the shortness of affected stems, quality was superb in all three media, and subsequently the work was scaled-up on a commercial site.

In 2014, in the first of two trials using cultivar 'Dynamite', bulbs were planted in 100% grower's peat-based medium, 100% coir, 100% 'Forest Gold' (a wood-derived 'potting substrate') or mixtures of grower's peat-based medium with coir (50:50 v/v), with anaerobic digestate (80:20 and 60:40 v/v) or with re-cycled green-waste (50:50 v/v). There were insignificant differences in stem length and weight between the growing media. Growing in grower's peat-based medium + anaerobic digestate mixes gave better leaf colour than growing in grower's peat-based medium alone, while growing in grower's peat-based medium + green-waste delayed picking by a week and gave some stunted stems with chlorotic leaves, slightly reducing the yield of marketable stems. In the second trial, 100% 'green-compost' was substituted for 'Forest Gold' and the range of grower's peat-based medium + anaerobic digestate mixes expanded (80:20, 60:40 and 40:60 v/v). As in the first trial the differences between growing media in average stem length and weight were insignificant, there were no between-media differences in cropping date, and no visual differences between plants grown in different

media.

In 2015 trials were conducted with cultivars 'Alma Ata' and 'Capistrano' planted in 100% grower's peat-based medium, 100% coir, 100% anaerobic digestate and the mixes grower's peat-based medium + anaerobic digestate (60:40, 40:60 and 20:80 v/v) and coir + anaerobic digestate (33:67 v/v). Plants grown in 100% anaerobic digestate were stunted, chlorotic and distorted, and those from grower's peat-based medium + anaerobic digestate (20:80 v/v) only marginally better. Lilies grown in anaerobic digestate + coir, despite making a good height, had chlorotic, mottled foliage. Plants grown in 100% grower's peat-based medium, 100% coir or the 'weaker' mixes of grower's peat-based medium + anaerobic digestate (40:60 and 60:40 v/v) were all normal and marketable. Stems were tallest grown in grower's peat-based medium, significantly shorter in 100% anaerobic digestate and slightly shorter in the anaerobic digestate mixes. Stems were heaviest grown in grower's peat-based medium + anaerobic digestate (40 and 60% anaerobic digestate) and lightest in 100% anaerobic digestate. There were some points of difference in the chemical analysis of the anaerobic digestate used each year. The nitrogen concentration of the 2014 sample was higher than in 2015, perhaps accounting for the better foliage colour in lilies grown in anaerobic digestate in 2014. The poorer performance of lilies in anaerobic digestate or anaerobic digestate-rich mixes may have been attributable to the high conductivities and pH of anaerobic digestate. Hence green-waste or green-compost may have a role in lily growing, but would need to be of a more consistent quality. Anaerobic digestate appears suitable to use mixed with grower's peat-based medium at up to 60% anaerobic digestate. Lilies also performed well when grown in 100% coir, which should also be considered as a peat alternative or diluent. Before growers adopt green-waste/green-compost or anaerobic digestate as materials for growing lilies, more needs to be known of their analysis and standardisation.

In 2016 the emphasis of lily trials changed to the assessment of growing in peat + wood fibre and peat + cocopeat mixtures, in comparison with grower's peat-based medium or coir. The mixtures comprised peat with 10, 20 or 30% wood fibre or cocopeat. Lily 'Dynamite' was used throughout. Lilies grown in 100% coir were stunted, but otherwise there were no indications of visual differences between plants in any treatment, and all treatments were picked within a few days. Growing in 100% coir produced stunted stems that were significantly shorter (70cm) than stems grown in the other eight growing media, in which stem lengths hardly varied (averages between 77 and 80cm). Stem weight was light in 100% coir (99g) with all other growing media yielding significantly heavier stems (averages between 126 and 151g). Growing in grower's peat-based medium gave stems averaging 126g, slightly lighter than for the peat + wood fibre mixes and significantly lighter than those growing in peat mix or the peat

+ cocopeat mixes. The results suggested that all trial mixes were worthy of further investigation as growing media for lilies in crates, but particularly the peat + cocopeat mixes. These had no adverse effects on growth, appearance and cropping, with the potential to reduce peat usage by 30%, possibly more.

General topic: herbicide trials

The loss of key active ingredients, such as chlorthal-dimethyl, propachlor and oxadiazon continues to be a major concern for growers of outdoor cut flowers. In 2015 parts of an AHDB Horticulture-funded project examining alternative herbicide treatments (HNS PO 192a) was carried out at the CFC site, using drilled china asters, larkspur, sweet william and wallflowers. 'Stomp Aqua' + 'Gamit 36 CS', applied post-drilling, pre-emergence, was safe and effective for use on drilled china aster, and this treatment could be followed up with a post-emergence application of 'Shark' if required. Tank-mix 'Stomp Aqua' + 'Goltix 70 CS' provided the best weed control and was the safest option in sweet william trials. In the drilled wallflower trial 'Butisan S', 'Gamit 36 CS' and 'Wing-P' (low rate) appeared safe when applied at drilling. 'Wing-P' (low rate) + 'Gamit 36 CS' also appeared to be safe on wallflowers as a tank-mix. 'Benfluralin' was safe as a pre-drilling incorporated treatment on wallflower and could be combined with some of the post-drilling treatments. The drilled larkspur trial proved challenging, partly because of phytotoxic effects from the herbicides used; nevertheless the trial gave some pointers to investigate in later trials. This work was followed up in 2016 as part of the CFC project, using transplanted china aster and drilled sweet william.

For china aster the aim was to follow-up the current recommendation for pre-planting 'Stomp Aqua' + 'Gamit 36 CS' (2.0 + 0.25L/ha). There were two alternatives to pre-planting 'Stomp Aqua' + 'Gamit 36 CS', 'Nirvana' (3.0L/ha) and 'Wing-P' (2.5L/ha), and each of these applications was followed up, three weeks post-planting, with 'Butisan S' (1.0L/ha), 'Venzar Flo' + 'Flexidor 500' (0.75 + 0.125L/ha) or 'Successor' (2.0L/ha), or had no further applications. There were large numbers of weeds on the untreated plots, and of the pre-planting treatments 'Wing-P' and 'Nirvana' were most effective in reducing weed numbers, while the tank-mix of 'Stomp Aqua' + 'Gamit 36 CS' was much less effective. Applied at this stage, however, 'Wing-P' and 'Nirvana' each resulted in some stunting of the crop, more seriously so in the case of 'Nirvana'. Using 'Stomp Aqua' + 'Gamit 36 CS' resulted in very slight stunting only.

Considering the post-planting treatments, 'Butisan S' was the most effective, with 'Venzar Flo' + 'Flexidor 500' and 'Successor' being less effective. Treatment with 'Butisan S' or 'Successor' resulted in very slight marginal leaf scorch to the youngest leaves at the time of spraying, though this was rapidly outgrown; there was no scorch when 'Venzar Flo' + 'Flexidor 500' had

been used. Overall, the combination of 'Stomp Aqua' + 'Gamit 36 CS' followed by 'Butisan S' was probably the best compromise between weed control and crop safety. On some sites 'Wing-P', either alone or followed by 'Venzar Flo' + 'Flexidor 500', might be an option.

For drilled sweet william the current recommendation is for 'Stomp Aqua' + 'Goltix 70 SC' (0.75 + 1.0L/ha) at drilling, followed-up at the four true-leaf stage by 'Shark' (0.4L/ha), and the aim of this trial was to see if this treatment could be bettered. Tank-mix 'Stomp Aqua' + 'Goltix 70 SC' at drilling was followed by either 'Butisan S' (1.5L/ha), 'Butisan S' + 'Shark' (1.5 + 0.4L/ha), 'Springbok' (1.6L/ha), 'Springbok' + 'Shark' (1.6 + 0.4L/ha), 'Successor' (2.0L/ha), 'Successor' + 'Shark' (2.0 + 0.4L/ha), 'Venzar Flo' + 'Flexidor 500' (0.75 + 0.125L/ha) or 'Venzar Flo' + 'Flexidor 500' + 'Shark' (0.75 + 0.125 + 0.4L/ha). In addition there was a treatment of 'Goltix 70 SC' (1.5L/ha) at drilling, followed by 'Shark' (0.4L/ha) and an untreated control.

In the untreated control, weed cover was complete, while in the 'Goltix 70 SC' - 'Shark' programme weed cover reached 47%. For the other programmes, all based on an initial application of 'Stomp Aqua' + 'Goltix 70 SC', weed growth varied widely. The most effective programme for weed control was follow-up 'Venzar Flo' + 'Flexidor 500' + 'Shark' (5% weed cover), followed by 'Springbok', 'Springbok' + 'Shark', or 'Venzar Flo' + 'Flexidor 500' (18–22%); the remaining programmes resulted in weed cover of 33% or more. In the early stages slight to mild stunting occurred in all treatments except the control, and the four treatments giving good ($\leq 22\%$) weed control gave relatively more stunting. However, the stunting effect was transient and the plants recovered. As a result of the trial the recommended herbicide programme would be the one giving the best weed control: 'Stomp Aqua' + 'Goltix 70 SC' at drilling followed by 'Venzar Flo' + 'Flexidor 500' + 'Shark' post-emergence.

Crop introduction (1) Crops first trialled in 2016

Cleome (Cleome hassleriana and cultivars)

Cleome hassleriana is a sturdy, attractive garden annual with unusual flowers - a possible candidate as 'something different' in cut flowers. In 2016 cultivars 'Cherry Queen', 'Colour Fountain Mix', 'Rose Queen' and 'Violet Queen' were sown into plugs and planted into beds in a tunnel. Establishment was satisfactory. There were no obvious differences in growth or development of the plants grown at two spacings (25 and 65 plants/m²). They were grown in two batches, transplanted in weeks 13 and 25; the later planting started flowering four weeks after the first and both were still flowering in October. Apart from their colours, there were no obvious difference between the cultivars. *Cleome* proved a very prolific crop that kept producing constant flushes of flowers over a long period, the flowers being large, showy and

distinctive.

Samples were subjected to standard VL testing. Cleome wilted very quickly after harvesting but recovered when re-hydrated in the chilled cabinet. Flowers, leaves and stems remained in acceptable condition on VL day 7. However, there was some abscission of flowers and shedding of the fine, black pollen (which was less when 'RVB Clear' rather than 'CVBN' had been used as the post-harvest treatment). The stems were somewhat difficult to handle because of their spines, and the plants and cut flowers have a distinctive aroma that some may find unpleasant. Despite their attractive and unusual flowers and adequate VL, further trials may not be appropriate because some consider the cleome's spines and aroma render them unsuitable for supermarket sales, and they may also be difficult to handle and hence unsuitable for use on a processing line. They may be suitable for supplying to florists for use in specialised situations where the flowers will not be handled by customers.

Craspedia (Craspedia globosa and cultivars)

With its slender unbranched stems and ball-shaped clusters of yellow flowers, craspedia is another example of a cut flower produced abroad but unfamiliar as a UK-grown crop. It is useful as a filler and may also be used as a dried flower. In 2016 cultivars three cultivars were grown in demonstration plots in 2016: 'Ellisse' and 'Paintball Globe' were obtained as rooted cuttings, potted-on and transplanted to beds in a tunnel in week 21, while 'Sun Ball' was obtained as seed, sown into plugs and transplanted to the tunnel in week 18. 'Ellisse' and 'Paintball Globe' gave large flushes of very strong, tall flowers but were very similar in shape to each other. Seed-raised 'Sun Ball' produced weaker plants with smaller flower-heads with shorter, kinked stems and fewer stems per m².

Samples of 'Ellisse' and 'Paintball Globe' were subjected to standard VL testing. All stems remained in acceptable condition on VL day 7, with no obvious differences between stems that received post-harvest treatment with 'RVB Clear' or 'CVBN'. Further samples showed that craspedia also dried well, the flowers retaining their colour. Craspedia is an unusual product with potential for sales as fresh or dried flowers.

Eremurus (Eremurus stenophyllus and other species and cultivars)

Eremurus stenophyllus is a rhizomatous plant producing tufts of linear leaves at ground level and bearing upright stalks (up to 1.5m-high) with dense racemes of yellow flowers. Interspecific hybridization has produced a wider range of colours including whites and pinks. As a demonstration, rhizomes of cultivars 'Cleopatra', 'Moneymaker' and 'Tapdance' were planted in beds in a polythene tunnel in week 45, 2015. In 2016 there was a low yield of the

tall, elegant flowers, while all plants showed conspicuous leaf senescence, even during flowering. The crop was left in place and as of January 2017 many shoots were emerging.

Gomphrena (Gomphrena globosa and G. haageana cultivars)

Gomphrena is another example of a cut flower produced abroad but unfamiliar to UK customers. An annual herbaceous plant bearing white, pink, purple or red solitary flower spikes at the stem tips, *gomphrena* can be used fresh-cut or dried. Nine cultivars, including 'Fireworks', four *G. globosa* cultivars and four *G. haageana* cultivars, were grown in a tunnel as demonstration plots in 2016. Apart from cultivar 'Fireworks', which was obtained as plug-plants and transplanted to the tunnel in week 25, they were obtained as seeds, sown into plugs in weeks 13 and 20, and transplanted to the tunnel in week 19 and 25. They started flowering around week 29, and initially the stems were very short and looked unlikely to suit as a cut flower. After three to four weeks, however, much longer stems, with real cut flower potential, were being produced. Samples were subjected to standard VL testing, and although the stems wilted rapidly after picking, they recovered once they were placed in a post-harvest treatment and cooled. The stems, flowers and foliage remained in acceptable condition on VL day 7. *Gomphrena* is very prolific and may have potential as a filler, though the soft foliage might make it difficult to handle in a commercial situation. Further trials will be carried out in 2017 with a view to forming an economic assessment.

Grasses, ornamental

Growers and customers are showing interest in a wide range of ornamental grasses as bouquet fillers. Several species and cultivars were demonstrated in 2016: *Bromus macrostachys*, *B. secalinus*, *Eragrostis elegans*, *Panicum elegans* 'Sprinkles', *P. miliaceum violaceum*, *Setaria italica* 'Mix', *Setaria pumila glauca*, *Sorghum nigrum*, *Stipa capillata* 'Lace Veil' and *Uniola paniculata* (sea oats). All were grown from seed which was either sown into plugs (week 12) and transplanted into beds in a polythene tunnel or outdoors (week 16 or 17), or direct-drilled to tunnels (week 18 or 28) or outdoors (week 18).

In tunnels all species had good germination and vigorous growth. Within species the only substantial difference was that the plugs took slightly longer than the direct-drilled crops to mature. Later planted crops flowered later, and this may be the way to achieve continuity and will be investigated in 2017. Powdery mildew was severe on *Bromus secalinus* in both tunnels and outdoors and with both planting dates. The outdoor plots were not a success, probably because of the weather, as the plants were frosted soon after planting, severely affected some species. There was a partial recovery but then they were held back by the wet weather in

June. Outdoor cropping will be examined again in 2017.

Samples of *Bromus macrostachys*, *Eragrostis elegans*, *Panicum elegans* 'Sprinkles', *P. miliaceum violaceum*, *Setaria italica* 'Mix', *Sorghum nigrum* and *Stipa capillata* 'Lace Veil' were subjected to standard VL testing. All samples remained in an acceptable condition on VL day 7; at this point some leaves of *Bromus macrostachys*, *Panicum miliaceum violaceum* and *Setaria italica* 'Mix' were showing some yellowing or dehydration, but probably not to an extent that would have resulted in the failure of a mixed bouquet since leaves of the other grasses were unaffected. Little or no shedding of anthers or pollen was seen.

Of all of the trials in 2016, the ornamental grasses generated the most interest amongst growers and others. There was a great variety in head form amongst the species grown, with *Panicum elegans* 'Sprinkles' and *Stipa capillata* 'Lace Veil' in particular elicited positive comments. All species tested have potential for use in mixed bouquets with a 7-day guaranteed VL. They appeared relatively easy to grow and there was a lot of interest from packers and supermarkets. They showed real promise for greater production in the UK. Trials should continue in 2017 and might also include regular cereals such as wheat.

Scabious (Scabiosa caucasica and S. atropurpurea cultivars)

The genus *Scabiosa* comprises annual and perennial herbs up to 0.6m-tall that, with their attractive flowers in a wide range of colours, and high yields, are often grown outdoors as cut flowers, though not in the UK. A large demonstration was set up in 2016, using cutting-raised plants of a new series: 'Blackberry Scoop', 'Cherry Vanilla Scoop', 'Cotton Candy Scoop', 'Lavender Scoop', 'Marshmallow Scoop', 'Raspberry Scoop' and 'Vanilla Scoop'. Plugs were transplanted into beds in a tunnel in week 18 and to outdoor beds in weeks 18 and 20. Slow to establish at first, they grew vigorously after pinching three weeks after transplanting. In the tunnel flowering started in week 26, with a heavy flush from week 29 onwards, and flowering was still continuing in October when the trial was terminated. Flowering was prolific, though the percentage of stems >45cm in length varied through the season and between cultivars. The outdoor plantings also cropped well, considering the prevailing conditions (frost a week after planting, water-logging in June, drought and high temperatures in August). It was only possible to obtain 'Cherry Vanilla Scoop' and 'Vanilla Scoop' in time for planting outdoors, and 'Cherry Vanilla' was prone to leaf chlorosis while 'Vanilla' performed poorly (they will be further investigated in 2017). Samples were subjected to standard VL testing and all remained in acceptable condition on VL day 7. Although care has to be taken when harvesting, they were relatively robust and easy to handle and did not appear to have complicated post-harvest requirements.

Scabious appeared to have great potential for cut flower production in the UK, both under plastic and outdoors. These new cultivars, with their attractive range of flower colours, high yields and good VL, have been well received by the industry. They have good potential for use by retailers in mixed bouquets. The only problem is the lack of stem length, which would limit how they could be utilised, which will also be investigated in 2017.

Solanum, ornamental (Solanum aethiopicum cultivars)

'Pumpkin-on-a-stick' is an unusual novelty that really caught the imagination of trial participants in the USA. The bright red 'pumpkins', actually resembling small (but toxic) tomatoes, are related to the winter cherry (*S. pseudocapsicum*) sold as a brightly fruiting house-plant. 'Pumpkin-on-a-stick' and 'Golden Eggs' were grown to assess the UK trade's response. Sown in plugs, they were transplanted into beds in a tunnel in week 18 or 19 at two planting densities.

'Pumpkin-on-a-stick' was an incredibly vigorous plant that started flowering in July, with fruits seen developing soon after. As expected the lower density produced sturdier stems than the higher density. The plants have vicious spines on stems and leaves, and removing these (as in the USA) would add costs and make it a specialty crop rather than a mainstream one. 'Golden Eggs' was interesting but very slow to mature and was not fully ripe before the covers had to be removed for the winter.

The industry did not appear to be enthusiastic about either of these novelties, although they may have a place with some of the smaller 'artisan' growers.

Crop introduction (2) crops with trials on-going

Basil (*Ocimum basilicum*)

There has been interest in growing basil as a fragrant filler for mixed bunches and bouquets, and in 2014 cultivars 'Dark Red Opal', 'Floral Spires Lavender', 'Floral Spires White' and 'Sweet Dani Lemon' were tunnel-grown as demonstration plots. They made good growth, with some cultivars having attractive foliage with potential for the suggested use. But the VL of these cultivars was poor (<5d) and further trials were postponed until better cultivars were available. 'Aromato' and 'Cardinal' are basil cultivars that were well received in ASCFG trials and in 2016 they were grown in demonstration plots. Plugs were transplanted to beds in a tunnel, growing well and producing good stems in August. Unfortunately post-harvest testing showed that the stems failed to take up water, confirming their poor VL.

Caryopteris (blue spiraea) (Caryopteris clandonensis cultivars)

Caryopteris is a popular garden shrub up to 1.5m-tall and bearing usually bright blue flowers in clusters near the branch ends. It had been included in trials in 2008, but concerns had been expressed then about the unacceptable smell sometimes associated with the crop. Although individual opinions varied and there appeared to be differences between cultivars, sufficient concerns had been raised to discourage further trialling at that point. In 2016 a new range of *caryopteris* bred specifically for cut flower production – the ‘Pagoda’ series. Three cultivars were grown in demonstration plots: plug-plants were transplanted into beds in a tunnel in week 21. ‘Pagoda Lagoon’ showed real promise because of its rich colour, but ‘Pagoda Blush’ was disappointing because of its rather insipid colour and short stems. The crop has been left *in situ* and its performance will be assessed in 2017.

Delphinium (Delphinium elatum cultivars)

Delphinium cultivars have previously been trialled extensively, but growers and others continue to debate whether more of their potential might be realised, say by the arrival of new cultivars. In 2014 ‘Sea Waltz’, ‘Sky Waltz’ and ‘Tango Dark Blue’ became available and were trialled, proving to be productive, with attractive flower spikes, and producing two or three flushes a year. Examples of a further new series, ‘Trick’, became available in 2016 and were also trialled. Plugs of three ‘Trick’ cultivars were transplanted into beds in a tunnel in week 19. They produced a good flush of flowers in mid- to late-July and a second heavy flush in early-September. The spikes were elegant, upright and well-liked by growers. In VL tests, all stems treated with ‘AVB’ lasted >8d in the vase, ‘RVB Clear’ being less effective. The ‘Trick’ series were considered to have good potential as straight bunches or for use in bouquets. There is scope for further post-harvest work and improvements through cultivar selection. Further assessments will be made in 2017.

Fillers, seed-raised

Recent years have seen an increase in growers’ interest in producing cheap, seed-raised fillers, either in tunnels or outdoors. A range of fillers was demonstrated in 2014 and 2015, and there were follow-up trials with *Ammi visnaga*, *A. majus* and *Daucus carota* (ornamental carrot) in 2016.

The earlier trials with ammi had shown that *Ammi visnaga* had the potential to produce big flower-heads for use in the larger, more expensive bouquets, alternatively smaller flower-heads could be produced by using higher planting densities or growing outdoors to reduce the vigour associated with protected cropping. *A. majus* was slow to mature but produced marketable stems from later sowings both in tunnels and outdoors. Stems of both species

achieved a long VL. There was marked enthusiasm from customers and growers for further comparative trials of ammi in 2016, and a range of cultivars was investigated: *Ammi majus* 'Bishop's Flower', 'Queen of Africa' and 'Snowflake', and *A. visnaga*, 'Green Mist', 'Mystique', 'Queen Anne's Lace' and 'White Spray'. Seed were direct-drilled in three rows along beds in a tunnel (week 18) and outdoors (week 20). The main picking period for *A. majus* cultivars was week 28 onwards and for *A. visnaga* cultivars from week 30 or 31 onwards. In general, growth in a tunnel was still rather too vigorous, but this has to be balanced against the protection afforded by growing in a tunnel.

Ornamental carrot 'Dana' was grown in the same way as ammi, but only in the tunnel. It produced flowers from week 25 onwards, generating great interest among growers. A further trial will be carried out in 2017.

Gypsophila (Gypsophila paniculata cultivars)

In 2014–2015 two new gypsophila cultivars with improved stem and flower qualities, 'Zinzi Discovery' and 'Zinzi Tyree', were grown in demonstration plots, but, probably due to late delivery and planting, the results were disappointing. Further cultivars were demonstrated in 2016: 'Andromeda', 'Beauty Bride', 'Dynamic Love', 'My Pink', 'Orstar', 'Paniculata', 'White Victoria' and 'Xlence'. Plugs were transplanted into beds in a tunnel in week 21. All varieties produced some marketable stems in 2016 but their full potential will be assessed in 2017 once the plants have become established.

Solidago (Solidago media cultivars)

Solidago is often used as a filler with flowers such as freesia, requiring small stems (weighing about 15g) which can be supplied cheaply from imports. Solidago had previously been included in CFC demonstrations in 2008, when stems from tunnel plantings averaged 124cm in length and 274g in weight and those from outdoor plots 106cm and 222g. Solidago stems of this size would be suitable only for bunch sales, for which there is unlikely to be a demand. To examine the crop further, three cultivars were grown in demonstration plots in 2016. Plugs were transplanted into beds in a tunnel in week 21. They produced a heavy crop of high quality stems in mid- to late-August but did not achieve a second flush. The plants were left *in situ* for their potential to be assessed in 2017.

Trachelium (Trachelium caeruleum)

Trachelium is not well known in the UK, although it is widely grown in the Netherlands and has been trialled and grown in the USA. It seemed a good subject to include in trials. After the initial trial of 2013 failed due to seed germination issues, replacement plugs of 'Corine Purple'

were transplanted in week 23 at 64/m² into beds in a tunnel. They produced an attractive display with flowering starting in late-August. A further trial in 2014 using plug-plants of 'Corine Purple' and examples from the 'Lake Michigan' series, were transplanted into beds in a tunnel in week 22 at 64/m². Initial growth appeared weak and budding-up occurred early but the stems lengthened and strengthened as the plants matured and each plant produced at least one heavy lead stem and a number of marketable side-shoots. Flower colours were impressive. The total 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 66cm and average weights (trimmed to 55cm) from 23g ('Lake Michigan White') to 32g ('Corinne Purple'). A later (week 27) planting of 'Lake Michigan Purple' was too late to achieve natural season flowering and the stems obtained were short.

A further trial was set up in 2015 to investigate transplanting dates (weeks 18, 22 and 25) and compare pinched and non-pinched (single-stemmed) crops, with the planting density kept at 64/m² for the non-pinched plants but reduced to 25/m² in the plots destined for pinching. Yields and stem length were satisfactory, though with large varietal differences, 'Lake Forrest White' and 'Lake Michigan Red' producing the tallest stems (70cm) and 'Lake Forrest Blue' and 'Lake Forrest Purple' the shortest (64cm), while trimmed stem weight varied little between treatments. The non-pinched plants grew vigorously and produced at least one or two side-shoots. The mean numbers of marketable stems ranged from 133/m², equivalent to 5.3 stems/plant (for pinched 'Lake Forrest Blue') to 273, equivalent to 4.3 stems/plant (for non-pinched 'Lake Michigan White'). Non-pinched plants cropped around 10 days earlier than pinched plants. VL testing showed a range of cultivar averages from 14 to 17days.

The greater number of stems/plant from pinched crops was of great interest for the economics of the crop and was further investigated with 'Lake Forrest Blue' and 'Lake Michigan White' in 2016. Plugs were transplanted in week 21 into beds in a tunnel at the same planting rates as in the previous experiment, and pinching took place two weeks after transplanting. The plants produced a superb crop with long, strong healthy stems. Pinched plants produced an average of just over 5 stems per plant, while non-pinched plants gave about 3.5 stems per plant.

There appears to be good potential for growing tunnel-raised tracheliums in the UK. In the past, tracheliums have had a poor reputation because of browning and the low weight of imported stems: the UK product seems much better – greener, taller and heavier. At present the high cost of plants is deterring growers from trying trachelium, but it may be possible to reduce costs by manipulating the number of marketable stems produced by pinching, varying planting density and testing other cultivars.

Veronica (Veronica longifolia cultivars)

Cultivars of *Veronica longifolia* are the most suitable veronica for cut flower production, having sufficient height and a good range of colours including blues. Veronicas had previously been demonstrated at the CFC in 2008, when four colours from the 'Spark' series had been grown in tunnels and outdoors. Across the cultivars, stems from tunnel plantings averaged 63cm in length and 29g in weight, and those from outdoor plots 44cm and 18g. At the time it was concluded that, for a number of reasons, not least a small production window, veronica cut flowers were unlikely to be economic in the UK. However, following revived interest, a further tunnel demonstration was suggested in 2016 and plots of three cultivars of the 'Skylark' series were grown. Plugs were transplanted to beds in a tunnel in week 19 at a density of 20/m². They produced a good crop of flowers during August and were prolific, with straight stems and well coloured spikes. A programme against powdery mildew is necessary. Veronicas show real potential as a cut flower in the UK and should be trialled further in 2017.

Zinnia (Zinnia elegans cultivars)

Zinnias have been grown previously at the CFC, in 2007 and 2008, when the industry was enthusiastic about their wide range of cheerful, vibrant colours. However, after picking, the hollow stems can collapse and bend just below the flower-head, making them unusable. Trials with zinnia were put on hold until varieties with improved stem strength became available. Trials started in 2013, using mainly the 'Benary's Giant' series but also the 'Oklahoma' series, which were considered superior to the other cultivars previous trialled, with better overall vigour, attractive flowers in a wide range of colours, and long stems. Overall, however, the VL results have given a rather unclear picture.

Early concerns about stem bending, due to the hollow stem, were not seen until late in vase-life, though VL was barely acceptable at a maximum of 7 days (2013 trials). In 2014 VL samples failed to survive until the end of the retail store phase; this may have related to earlier infection with bacterial blight, although it was also suggested that zinnias may be sensitive to cool-chain conditions. In tests in 2015 they performed reasonably well, most stems lasting beyond the guarantee day, day 5, but between vase-days 5 and 10 they failed quickly, and on average <50% survived beyond vase-day 10. Stems failed for a variety of reasons, including botrytis in the bud and bending of the neck, but mainly for discolouration around the edges of the petals. Interestingly, stems harvested at the early stage with apparently weak necks, appeared to become firmer in the neck rather than bending, as had been expected, but VL was not obviously shorter for the most advanced stems than for those cropped at an earlier stage. It was suggested that neck bending may occur only when stems are picked at an over-

mature stage, and that otherwise the developmental stage at picking is of little importance. There appeared to be large differences in performance between cultivars, with extremes of 10 days and 6 days. There were only minor differences in flower quality scores between conditioner treatments ('CVBN' treatments and 'RVB'). Finally, in 2016, the petal browning seen earlier did not arise until later in VL, and seemed a part of natural aging; very few instances of stem bending were observed; and the first stem deaths occurred on VL day 6 and the last on vase day 10, with an average VL of 8.5 days. Although further post-harvest work is ideally needed, at the present time it seems zinnias have an acceptable VL, and with the colour range available their presence in a bouquet should ensure they are of interest to retailers.

Financial benefits

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

Antirrhinum: amount extra grown in 2016 approximately 1.0ha with an annual farm-gate value of £115,000.

Hardy perennials: amount extra grown in 2016 approximately 10ha with a farm-gate value of £35,000 per ha which is based on hypericum with an average yield figure which takes into account that some of these are relatively new plantings and have not yet reached their maximum yield. This represents an annual farm gate vale of approximately £350,000

Lisianthus: amount extra grown in 2016 approximately 0.75ha with an annual farm-gate value of about £114,000 on an 80% cut percentage.

'Others' are a category that is not easy to give an accurate estimate of area to but when taking into account outdoor bupleurum, trachelium and the various crops planted by the large number of small artisan flower growers, this could represent between another 2 and 5 ha of additional plantings which could be an additional annual farm gate value of between £50,000 and £200,000.

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 €46 per 1,000 plus delivery.

Hardy perennials, using hypericum as an example: planting density around 2.4 plants per/m², 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 €1.60 per plant and snowberries at about €2 per plant. The expected life of these crops would be between 10 and 20 years.

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 €95 per 1,000 (dependent on variety) plus delivery.

Trachelium: planting density around 64 plants/m² of bed with at least one lead-stem harvested per plant and with some varieties in 2016 also producing one or two additional side-shoots; the plant cost is approximately €75 per 1,000 plus delivery. The economics of a pinched crop should also be considered by growers to reduce the cost of plant material.

Scabious: planting density between 6 and 8 plants/m² of bed with the propagator estimating a yield of around 100 stems/m² being harvested (although initial trials have indicated that this could be an underestimate); the plant cost is approximately €0.85 each.

Veronica: planting density around 20 plants/m² of bed with the propagator estimating a yield of around 80 stems/m² per flush (early trials indicate one flush in the first year and two in the second); the plant cost is approximately €0.70 each.

Astroemeria: planting density around 5 plants/m² of bed with yields of between 200 and 400 stems/m² being harvested (depending on the year and variety); the plant cost is approximately £3.50 or £4.50 each depending upon pot size.

In addition to the new crops being grown by commercial cut flower growers a wide range of new products are also been grown on a small scale by a large number of artisan growers. A number of UK mail order companies have also taken on board products such as annual dianthus, dahlia and zinnia. And while these growers are unlikely to be paying an AHDB levy, any increase in the production of UK cut flowers can only be good for the industry as a whole.

Action points

The 2016 trials highlighted the following new product opportunities that could be considered by UK growers who are interested in expanding the range of cut flowers they produce and offer:

Craspedia, gomphrena, scabious and a range of ornamental grasses, which provide novelty in flower form and colours, and grow well in tunnels and have shown promise outdoors. Some of these (especially scabious and craspedia) have also been successfully trialled in glasshouses on grower holdings in 2016.

Ammi majus and *Ammi visnaga*, which are economic, direct-drilled fillers growing well in tunnels and outdoor beds.

Trachelium, which has promise as a new UK crop grown in tunnels to complement production in glasshouses.

Non-protected cultivars of alstroemeria, which grow well as a natural-season tunnel crop, eliminating the high plant costs associated with protected varieties, while still producing a large yield of high quality stems.

Lily growers looking to take advantage of peat reduction could consider growing them in crates of peat + wood fibre or peat + cocopeat mixtures, which give yields and quality as good as or better than standard peat-based growing media.

Trials on herbicide programmes showed that the following treatments gave the best compromise between weed control and crop safety:

For transplanted china aster, apply 'Stomp Aqua' + 'Gमित 36 CS' pre-planting followed by post-planting 'Butisan S'.

For drilled sweet william, apply 'Stomp Aqua' + 'Goltix 70 SC' at drilling followed by 'Venzar Flo' + 'Flexidor 500' + 'Shark' post-emergence.