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

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AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Lyndon Mason
Director
Cut Flower Centre Ltd

Signature ..... Date .....

CONTENTS

GROWER SUMMARY

Headline

- ‘German asters’, new varieties of China asters and exemplified by the ‘Krallen’ series, have potential as a new line for UK flower growers. Annual dianthus varieties ‘Neon Purple’ and ‘Rose Magic’ performed consistently well, showing only a small response to varying planting week and density ‘Karma’ dahlias were striking plants when grown in a Spanish tunnel, but have so far failed to reach the 11 days of shelf life considered necessary for commercial production.

Background and expected deliverables

The past 20 years have seen a marked increase in *per capita* purchases of cut-flowers in the UK. Consumption has moved up from what was once a very low level by European standards, and there has been a spectacular, continuing increase in the imports of cut-flowers to the UK. Despite this, the UK’s own production of cut-flowers is still limited. Proximity to the final market would greatly benefit the UK cut-flower industry, delivering freshness without air-miles, but a lack of know-how may be critical in holding back expansion and enterprise. In 2007 the Cut Flower Centre (CFC) was established at Kirton, Lincolnshire, to supply this practical knowledge, moving in 2009 to Rookery Farm, Holbeach St Johns, Lincolnshire, were it is now run as a discreet unit under the control of the CFC Management Group.

The expected deliverables of the CFC are:

- Demonstrations, trials and problem-solving experiments in cut-flower production
- Evaluation of selected crops on a commercial scale
- ‘Best Practice’ for the most promising varieties
- Promotion of UK cut-flower production
- Stimulation of further R&D and promotional projects.

Summary of the project and main conclusions

<u>China aster (‘German asters’)</u>

CFC trials in 2008 had shown that ‘German asters’ have very substantial market potential in the UK. However, a number of different issues need to be addressed, including the effects of:

- planting density;
- planting date;
- pinching (stopping);
- double-cropping.

Plug-plants of asters 'Krallen Golden' and 'Krallen Kameo' were transplanted into beds in a Spanish tunnel during weeks 24, 26, 28 and 30 at three planting densities (spacings), 32, 48 and 64 plants/m^2. Plug-plants of 'Gala Lavender' were also planted, in weeks 28 and 31. Most plantings needed some gapping-up, but otherwise established well. However, the plants became infected by both tomato spotted wilt virus (TSWV) and impatiens necrotic spot virus (INSV), probably due to a chance infection by western flower thrips (WFT), and indicated a need to apply prophylactic sprays when growing the crop.

Effect of planting density

As would be expected, the lower density produced heavier stems, with stems at 32 plants/m^2 being approximately 26 to 40% heavier that those grown at 64 plants/m^2. However, most stems grown at the higher density of 64 plants/m^2 still produced stems heavy enough to meet the current supermarket specifications, so there is little commercial advantage in planting at lower densities unless the crop is being grown for a high specification outlet. Planting density did not have any significant effect on stem length.

Variety trials

In a CFC trial undertaken in 2007, 'Gala' and 'Krallen' were found to be the most promising of the 'German aster' varieties available at the time. The 2009 trials demonstrated that 'Krallen' maintained an adequate head size throughout all of the planting dates, while the later planting of 'Gala' did not give a large enough head size to differentiate it from the 'Matsumoto' series. Varietal differences will be further investigated in 2010.

Planting date

As would be expected, the quality of the stems deteriorated with the later planting dates. Weeks 28 to 30 were the latest the asters could be planted to achieve a commercially viable crop. These results were confirmed by larger-scale evaluations at two commercial nurseries.

Pinching (stopping)

A plot from each planting date and density was pinched (stopped) to three or four leaves within 2 weeks of planting (as for natural-season chrysanthemums), with the expectation that they would produce three or four breaks per plant. However, the trial demonstrated that this

technique was not successful with these varieties. The results varied, with some plants producing a 'gall-like' callus but no shoots, others throwing a new lead shoot with no breaks, and some throwing weak shoots which did not produce marketable stems. Hence none of the pinched plots ultimately produced any marketable stems from any of the planting dates, densities or varieties.

Double-cropping

Single-stem production seemed to be the most appropriate technique to produce the 'German aster' specification currently required by UK supermarkets. The trial investigated the possibility of double-cropping using two different techniques: the first option was to harvest all of the side-shoots separately and amalgamate them into a bunch, while the second was to remove the lead shoot when it matured and allow the side-shoots to mature before harvesting the remaining shoots as a complete stem. Neither of these techniques produced a product of a suitable specification for UK supermarkets, but they could possibly be sold via outlets that require a 'bunched' crop. (The first technique produced short, weak stems, the second produced a stem of suitable length and weight, but it did not look attractive in the sleeve because the flower-heads were at different heights and were borne on weak stems.

The trials resolved many of the previous issues about growing these aster varieties, but other factors still need to be resolved, including height restriction (probably using daminozide available as B-Nine or Dazide), achieving earlier cropping, seed provenance (varieties appear to come from more than one source), and the performance of 'Gala' from earlier planting dates. It is proposed to look at these issues in 2010, both in trials at the CFC and in further evaluations on a commercial nursery.

<u>Dianthus (annual)</u>

Previous trials had shown that annual dianthus performed very well under Spanish tunnels and seemed to lend itself to season extension. Earlier work also demonstrated that there was very little difference in performance between a pinched crop and un-pinched crop, so it was decided to examine planting density and season extension during the 2009 trial. The aim of the trial was to:

(1) to determine the economics of producing a single-stem crop growing at planting densities from 64 to 98 plants/m^2
(2) to investigate seasonal extension using transplanting dates from week 24 to week 30.

Plug-plants of three cultivars ('Neon Cherry', 'Neon Purple' and 'Rose Magic') were transplanted into 3m-long beds in a Spanish tunnel during weeks 24, 28 and 30. Each 3m bed was planted with 1m of each of the three cultivars. All plantings established well and grew without significant problems arising.

There was no significant difference in yield or stem weight from the different planting densities. The average cropping dates showed that 'Neon Purple' was generally about half a week later to pick than the other cultivars. Planting density had no effect on cropping date, and the duration of the cropping period was not greatly different between either cultivars or planting densities.

'Neon Cherry' produced more stems overall, but they were consistently shorter and lighter than those of the other two cultivars. 'Neon Purple' and 'Rose Magic' were consistent in the quality (weight and length) of stems produced across different planting dates and densities, but yields were highest when planted at week 28, somewhat less when planted at week 24, and considerably less when planted at week 30. If the crop is extended to planting in week 30, the quality may be adversely affected, and any further season extension seems unlikely to be worthwhile.

This trial was mirrored by evaluations on two commercial holdings, one grower producing a crop for a UK supermarket. From these trials it became clear that the first lead stem produced by the plant was of much better quality (as would be expected) and is suitable for bouquet work. The side-shoots were of much lower quality than the lead stem, and suitable only for bunching. The conclusions from these trials were that for bouquet work the higher planting densities were more appropriate, but for bunching work the lower density seemed to be the more cost-effective.

The following approximate production costings have been supplied by a commercial grower and can be used as a rough guide to determine the economics of production.

Cost of plant (plug) 6p, planting cost 1p per stem, general cultural tasks (laying nets, clearing out etc) 0.5p per stem, growing costs (including watering, fertiliser, and spray application etc.) 0.5p per stem and harvesting 2.5p per stem (needs to be done very carefully owing to the crop being very brittle and easily broken).

On average the commercial crop produced about 85% first class stems.

Trumpet antirrhinum

Ball Holland (now Florensis) introduced a new range of antirrhinum with a trumpet-shaped flower rather than the traditional shape. In 2009 the CFC was supplied with two trial lines, AHC 129 and AHC 130. These were planted as a demonstration trial both in outside plots and in Spanish tunnels during week 28, at a density of 64 plants/m^2. Both the performance of the plants, and the response of growers and 'the market', were very encouraging. More varieties will be included in trials in 2010.

'Karma' dahlia

Dahlias are considered to have fantastic visual sales appeal, but suffer from a generally poor vase-life. The 'Karma' series are considered to have the best vase-life potential, so a demonstration was set up to inform growers of their potential value, and, importantly, to investigate their vase-life objectively.

Cuttings of 18 'Karma' cultivars were planted into beds in a Spanish tunnel and outdoors during week 24 (some, which were poorly rooted at receipt, were grown-on and planted out later, in week 26). The protected crop produced very good quality stems and was high yielding, whereas the outside crop struggled to make a good stem length during the extreme summer of 2009.

A range of vase-life treatments were tried, but none was found to have any significant impact on the vase-life of the crop, confirming the findings from earlier trials undertaken at the same vase-life facility. Stems failed to reach the 11-day total shelf-life/vase-life required, no matter which treatment was used. The foliage had generally wilted or browned by day 6 or 7, and all the petals had wilted by day 7 to 8, or occasionally day 9. In about half the vases one or more of the flower conditioner/food treatments resulted in a delay of about 1 day in wilting, compared with the controls (water), still well below the required post-harvest life, and there was no consistency in the treatments leading to this delay.

The Dahlias tested therefore elicited a very encouraging response from many who visited the trials site – the plants created great visual impact and the stems were strong and colourful. Unfortunately their vase-life was disappointing: despite testing various post-harvest and vase-life solutions, the shelf/vase-life never approached the total of 11 days required (6 days from picking to leaving the retail store, plus 5 days minimum in the vase). Unless this shelf-life/vase-life issue can be rectified using other cultivars and (or) treatments, it is difficult to see how 'Karma' dahlias could be taken forward as a commercial cut-flower.

The CFC Management Group is looking at the possibility of instigating a University based research project to look at this problem in 2010.

Phlox

Plots of seven phlox varieties planted at Kirton in 2007 were dug out and, after a period of cold storage, transplanted at Rookery Farm. They established well and were grown-on to assess their continuing flowering potential.

The cultivars were highly variable in their productivity. 'Sugar Missy' was relatively early, and produced the greatest number of stems with the greatest length and a reasonable weight. It had the longest vase-life, 18 to 21 days, but there was yellowing foliage by day 11 in one out of three samples. 'Magical Dream' and 'Magical Fragrance' also gave good numbers of stems, and had average picking dates, stem weights and stem lengths, and vase-lives of 12 to 15 days.

'Ice Cap' produced lower yields and was 'mid-season', had the heaviest stems and long stems, but its vase-life was well below 11 days. 'Miss Fiona' and 'Miss Marple' also produced lower yields, but were early, with long, heavy stems and vase-lives that varied between 12 and 19 days in tests.

'Magical Surprise' was the latest flowering variety and consequently yielded few stems within the period of the trial. Stem weight was average, but stem length was relatively low. It produced insufficient stems for vase-life testing.

Clearly some phlox varieties show potential for greater production, with good vase-lives. Further cultivar comparisons may be worthwhile in future years.

Autumn column stocks

A Dutch propagator had suggested that if column stocks were propagated in peat blocks rather than small plugs, they should flower both earlier and more evenly. The logic behind this thinking was that the blocks would produce a larger and more robust plant that would grow away quickly and produce a better quality crop.

However, the trial demonstrated that there was no advantage from planting blocks because the crop still flowered very unevenly. The later plantings did not flower before the tunnel

covers needed to be removed for the winter. These findings were confirmed by parallel evaluations undertaken on two grower holdings.

Brassica (ornamental)

A small trial was established to compare direct-seeding with traditional plug production. Unfortunately, owing to extreme, dry weather conditions, germination was very erratic and no meaningful results were obtained. This trial will be undertaken again in 2010.

Financial benefits

The project identified a number of crops having definite potential for further exploitation and commercialisation in the UK. It is estimated that two or three new products would help to maintain a significant number of larger or medium-sized businesses.

Action points for growers

'German asters'

- The optimum planting density is 64 plants/m^2.
- Week 30 is the latest recommended planting date to maintain maximum stem length and weight.
- The crop should be grown as a single stem and not be pinched.
- 'German asters' appear to be susceptible to TSWV and INSV (spread by WFT). Prophylactic thrips sprays are therefore recommended.
- To maintain flower head size at later plantings 'Krallen' should be selected over 'Gala'.

Dianthus (annual)

- This crop performs superbly as a cold-protected crop.
- It is best grown as a single stem and should not be pinched.
- Planting density seems to have little effect on the total number of stems produced, but the lead stem is obviously much heavier than the side-shoots.
- The final market for the product will probably determine the planting density used, with lower densities being used for bunch work and higher densities (giving more lead stems) being used for bouquet work.

‘Karma’ dahlia

- At the current time the vase-life of Karma dahlias is too short to enable them to be marketed through UK supermarkets, however they may have potential for sales as garden plants or as cut-flowers through local outlets.

Phlox

- This crop has good market potential but is best produced under protection to ensure consistent high-quality stems.
- Variety selection will depend on the requirement of the market outlet.
- Phlox suffer from powdery mildew (though the ‘Magical’ series showed remarkable resistance to it during 2009) so appropriate fungicide applications are required during plant development.

Column stocks for autumn flowering

- There doesn’t appear to be any benefit in growing autumn stocks in peat blocks rather than small plugs.

Growers who would like to know about other novel cut-flowers are encouraged to contact the project leader or the HDC with suggestions for the Centre’s programme in 2010 and beyond.

SCIENCE SECTION

Introduction

Despite consumer trends that have led to a huge increase in the sales of cut-flowers in the UK over the past 20 years, few of these flowers are grown in the UK, the great bulk of them being imported. Why have UK growers not responded more positively to this consumer trend? After all, they are close to their markets and the climate is suitable for growing many of the traditional summer flowers that are popular as cut-flowers today.

One contributory factor is a lack of know-how – not surprising, perhaps, given that the number of potential species runs into hundreds and that the seed-houses are producing huge numbers of new cultivars and other introductions. **But innovation is the key to a successful UK cut-flower industry: we need to identify those products that can be grown well and efficiently under UK conditions and which appeal to both mass and niche markets. Some multiple retailers are committed to buying fresh UK produce if the price, availability and quality are right. Two or three new products would maintain a significant number of larger or medium-sized businesses.**

The initial project aim was the establishment of a cut-flower trials centre for the UK, situated in South Lincolnshire where a high proportion of these crops are grown, and where UK fresh produce logistics are concentrated. The need for a Centre was identified by cut-flower growers themselves, and the project has been industry-led throughout. Growers and other businesses associated with the local cut-flower industry drew up the application and established a company, Cut Flower Centre Ltd, as the legal vehicle for running the Centre. During 2007 and 2008 trials were carried out under contract by The Kirton Research Centre, Warwick HRI, and funded jointly by the HDC and the Lincolnshire Fenlands LEADER+ Programme. Owing to the closure of Kirton in February 2009, the trials were moved to Rookery Farm, Holbeach St John, Lincolnshire. Starting in 2009 the Cut Flower Centre (CFC) was funded by the HDC BOF and PC Panels, with a contribution from Waitrose. It is now operated as a discrete unit at Rookery Farm under the complete control and direction of the CFC Management Group which consists of local growers, marketing companies, supermarkets and consultants.

The aims of the CFC remain as:

- Demonstrations, trials and problem-solving experiments in cut-flower production
- Evaluation of selected crops on a commercial scale
- Establishing ‘Best Practice’ for the most promising varieties

- Promotion of UK cut-flower production
- Stimulation of further R&D and promotional projects.

These are specific aims - but there is also a 'bigger picture': to grow the concept of a dynamic UK cut-flower industry that is confident, world-class, and not dependent on what is left to grow after imports have satisfied the bulk of the market. Establishing a national cut-flowers trials centre will help put UK cut-flower producers and packers 'on the map'.

This Report presents the full results of the 2009 trials carried out in the field and under Spanish tunnels.

Materials and methods

Trials and demonstrations at the CFC

The CFC facility at Rookery Farm, set up in early-2009 at Joys Bank, Holbeach St Johns, Spalding, Lincolnshire, consists of a single-span 'Haygrove' tunnel (7.9m wide x 38.1m long), a triple-span 'Pro Tech' tunnel (overall 22.7m wide x 38.0m long) and an area of outside beds of about 600m^2. The whole area is irrigated using zoned, fully computer-controlled lay flat tubes. Wind breaks of 2.5m-high polypropylene netting have been erected at each end of the 'Pro Tech' tunnels.

The soil at CFC is heavy silt, slightly more difficult to manage than the medium silt at Kirton where the previous trials and demonstrations had been conducted. Prior to trialling, the usual ploughing, agricultural soil analysis, fertilizing according to needs, and cultivation were carried out. Beds, 1m-wide, were marked out, three beds per tunnel, and beds of equivalent size and arrangement were made outside adjacent to the tunnels. The plots for demonstrations and trials were typically 3m-long, with 1m-long unplanted guard areas between plots. All transplanting was done through 1.2 m wide-wide *Black Flame* perforated polythene film. Each bed was irrigated with three lay-flat tubes, and each bed was divided half-way along the tunnel to provide two irrigation zones per bed.

Crop husbandry protocols were agreed between the key staff at Rookery Farm and the CFC Management Group with the aim of achieving good commercial practice, adapted as necessary to suit small trial plots. A standard liquid feed, was applied to all plots at weekly intervals, increasing to every other irrigation from when deemed necessary. Appropriate

insecticides, fungicides and slug pellets were applied as needed, according to recommendations.

The species and varieties trialled or demonstrated at the CFC in 2009 are listed in Table 1, along with the dates of transplanting or direct-drilling, whether grown outside or in tunnels, planting density, cropping stage, any special treatments given, and whether transplanted crops were obtained as 'plug-plants', seed, rooted cuttings or raised in peat-blocks. The planting dates, plant density (spacing) and whether plants were pinched or supported by netting were as appropriate to each species. Details of the layout of each trial are given under the 'Results and conclusions' for each species.

The crops and results for the project, along with plans for further work, were assessed at regular meetings by the industry members of the Management Group and others as appropriate. Stems were picked at the appropriate stage for each crop. The total number of stems picked was recorded, along with the picking dates, lengths and weights of individual stems. Photographs and notes were taken for the 'observational' plots, but no formal records.

Evaluations at commercial nurseries

In 2009 evaluations of annual dianthus and of column stocks for autumn flowering were grown on two commercial nurseries, Lambs Flowers, Pinchbeck, Lincolnshire, and J A Collison & Son, Terrington St Clement, Norfolk. These evaluations complemented, on a larger scale, the trials carried out at the CFC.

Vase-life trials

Freshly harvested stems of marketable quality were cropped from the trials and evaluations and subjected to standard vase-life testing. Full details of post-harvest treatments are given under the 'Results and conclusions' for each species.

Table 1. Cut-flowers grown at the CFC in 2009

Species and purpose of trial	Varieties, series, (producer/supplier)	Transplanting or drilling dates	Site and planting density	Picking stages and specs
1. Antirrhinum ('trumpet' varieties) (*Antirrhinum majus*) Demonstration plots	Two new varieties coded: AHC 129 AHC 130 (Ball Holland)	Transplanted 9 July	'Haygrove' tunnel and outside 64 plants/m^2	Not specified
2. Brassica (ornamental) (*Brassica oleracea*) Direct-seeding compared with transplanting	'Bright White' (Ball Holland) White Crane (Combinations)	Direct-drilled week 24 Transplanted week 26	Outside in five rows, 5cm apart in outer rows, 7cm apart in inner rows Outside 64 plants/m^2	When there was significant colour change and stem length >65cm
3. China aster ('German asters') (*Callistephus chinensis*) Determination of ideal planting date, density, pinching, double-cropping and varietal evaluation	'Krallen Golden' 'Krallen Kameo' (Ball Holland) 'Gala Lavender' (Combinations)	Transplanted weeks 24, 26, 28 and 30 Transplanted weeks 28 and 31	'Pro Tech' tunnels 32, 48 and 64 plants/m^2 As above	Not specified
4. Dahlia (*Dahlia* hybrids) Demonstration plots	'Karma' series 'Lagoon' 'Choc' 'Prospero' 'Amanda' 'Bon Bini' 'Thalia' 'Ying Yang' 'Sangria' 'Maarten de Zwaan' 'Ventura' 'Royal' 'Serena' 'Fiesta' 'Red Corona' 'Corona' 'Pink Corona' 'Irene' 'Naomi' (via William van Braght)	Transplanted week 24 or 26	'Pro Tech' tunnel and outside 9 plants/m^2	50% of petals reflexed (unless otherwise stated)

Table 1. Cut-flowers grown at the CFC in 2009 continued....

Species and purpose of trial	Varieties, series, (producer/supplier)	Transplanting or drilling dates	Site and planting density	Picking stages and specs
5. Dianthus (annual) (*Dianthus barbatus*) Planting date and density trial	Amazon series 'Neon Cherry' 'Neon Purple' 'Rose Magic' (Ball Holland)	Transplanted weeks 24, 28 and 30	'Pro Tech' tunnel 64, 80 and 96 plants/m^2	Stage 2, 3 to 5 florets open and stem length >60cm
6. Phlox (*Phlox paniculata*) Variety demonstration	'Icecap' 'Miss Marple' 'Miss Fiona' 'Sugar Missy' (Bartels) 'Magical Dream' 'Magical Fragrance' 'Magical Surprise' (Kolsters)	Stock plants transplanted from Kirton	'Haygrove' tunnel 16 plants/m^2	With a self-supporting stem, spike length >8cm and stem length >52cm
7. Sedum (*Sedum* spp.) Variety demonstration	*Sedum* 'Herbstfreude' *S. hybrida* 'Autumn Joy' *S.* 'Matrona' *S. spectabile* 'Brilliant' *S.* 'Superior Pink' *S.* 'Superior White' *S. telephilium* 'Carl' *S. telephilium* 'Munstead Dark Red' (Combifleur, Kolsters)	Stock plants transplanted from Kirton	Outside 6 plants/m^2	50% florets showing colour, stem length >50cm and bunch weight 300g
8. Column stocks (for autumn flowering) (*Matthiola incana*) Plug versus peat block trial	'Centum White' (Combinations)	Transplanted weeks 26, 28 and 33	'Pro Tech' tunnel 64 plants/m^2	Not specified

Picking stages of 'German asters' (left) and annual dianthus (right)

Results and conclusions

1. ANNUAL DIANTHUS

The trial was set up (1) to determine the economics of producing a single-stem crop growing at different planting densities and (2) to investigate seasonal extension using different transplanting dates.

Plug-plants of three cultivars from the 'Amazon' series ('Neon Cherry', 'Neon Purple' and 'Rose Magic') were transplanted into beds in a tunnel in weeks 24, 28 and 30 (11 June, 8 July and 23 July) at three planting densities (64, 80 and 96 plants/m^2). For each planting date x planting rate combination, a single 3m-long bed was planted with 1m each of the three cultivars. All plantings established well and grew without significant problems arising. All stems were cropped and 40 to 60 stems, as available, taken at random from each for recording individual stem weights and lengths.

The results are given in Figures 1 to 5, which can be scanned across to see the differences between cultivars, then planting densities, and then planting dates. The data are also presented with standard errors (SEs) in Table 2; the SEs indicate consistency and a relatively low variance in the data.

'Neon Purple' was generally about half a week later to crop than the other cultivars whilst planting density generally had no effect on cropping date (figure 1).

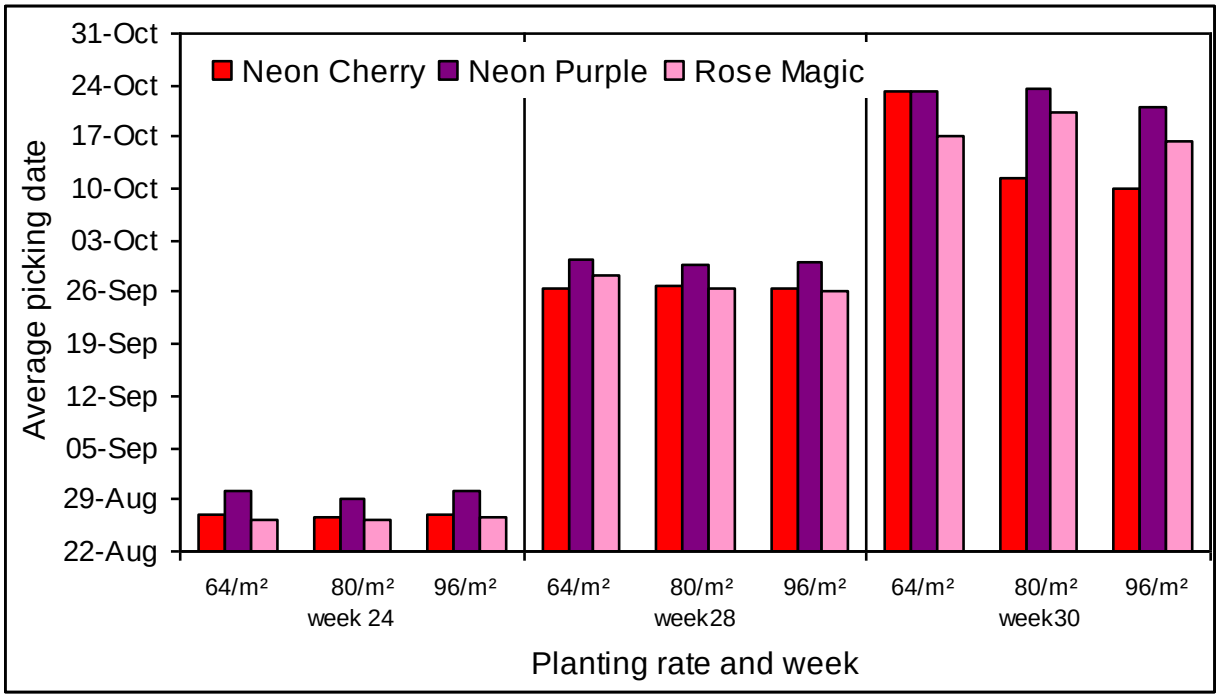

Figure 1. Annual dianthus, 2009: Average cropping dates

The duration of the cropping period (days from first pick to last pick, figure. 2) differed little between either cultivars or planting densities, but was longest following planting in week 28. Actual first and last picking dates are detailed in Table 2.

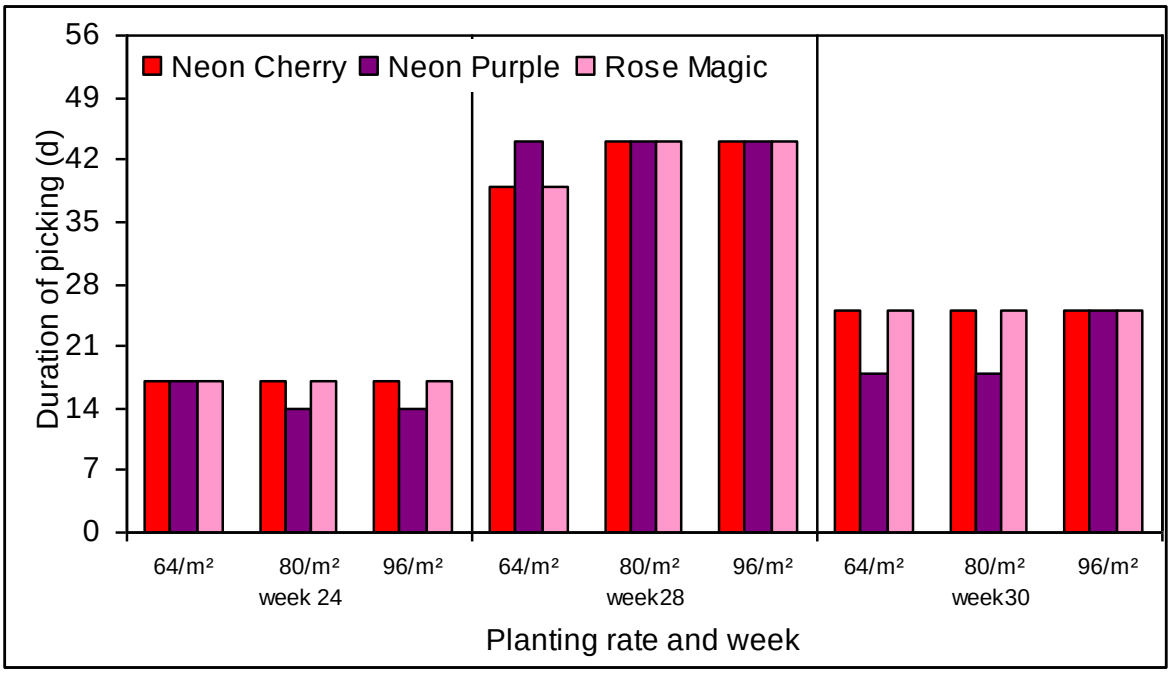

Figure 2. Annual dianthus, 2009: Crop duration

In terms of productivity, growing 'Neon Cherry' and planting in week 28 yielded most stems, and 'Neon Purple' and planting in week 30 the least (figure 3). Overall, planting density had little effect on the yield of stems, implying that the increased competition experienced under higher planting densities negated any possible advantage of producing more stems per unit area.

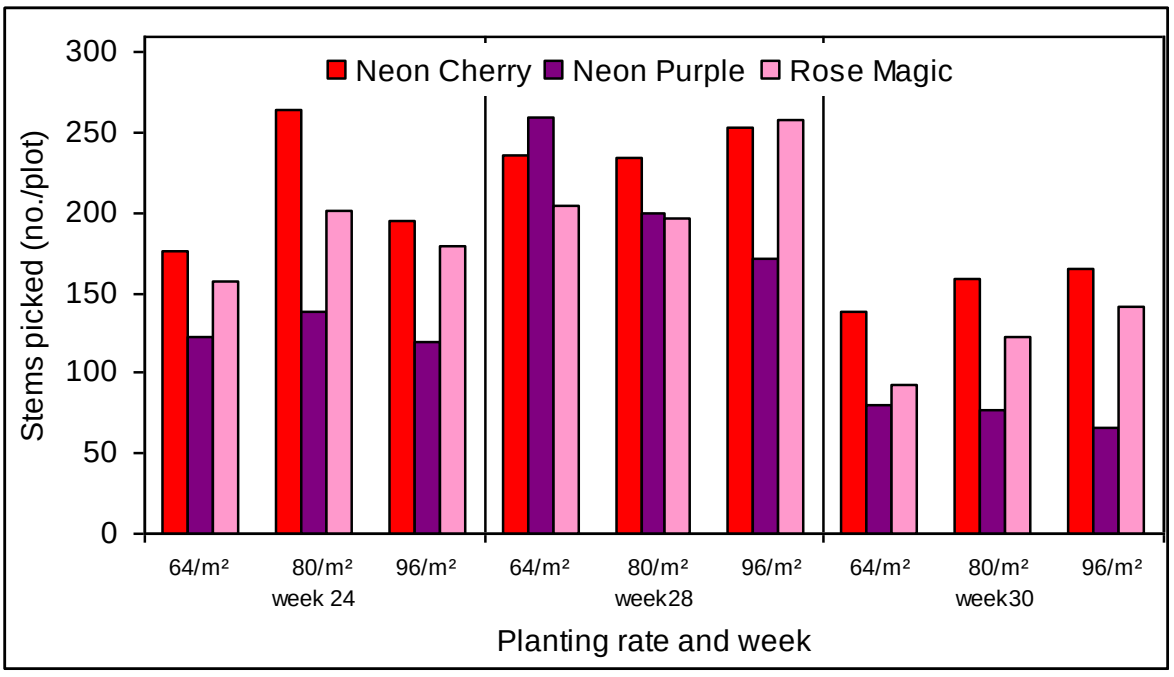

Figure 3. Annual dianthus, 2009: Stem yield

Stem quality was assessed as average stem weight and length (figures 4 and 5). 'Neon Cherry' consistently produced the lightest and shortest stems which were generally half the weight of the other two cultivars and around 10cm shorter. However, it was clear that there was little or no consistent effect of either planting density or planting date on stem weight and length. Stem length was a less variable parameter than stem weight.

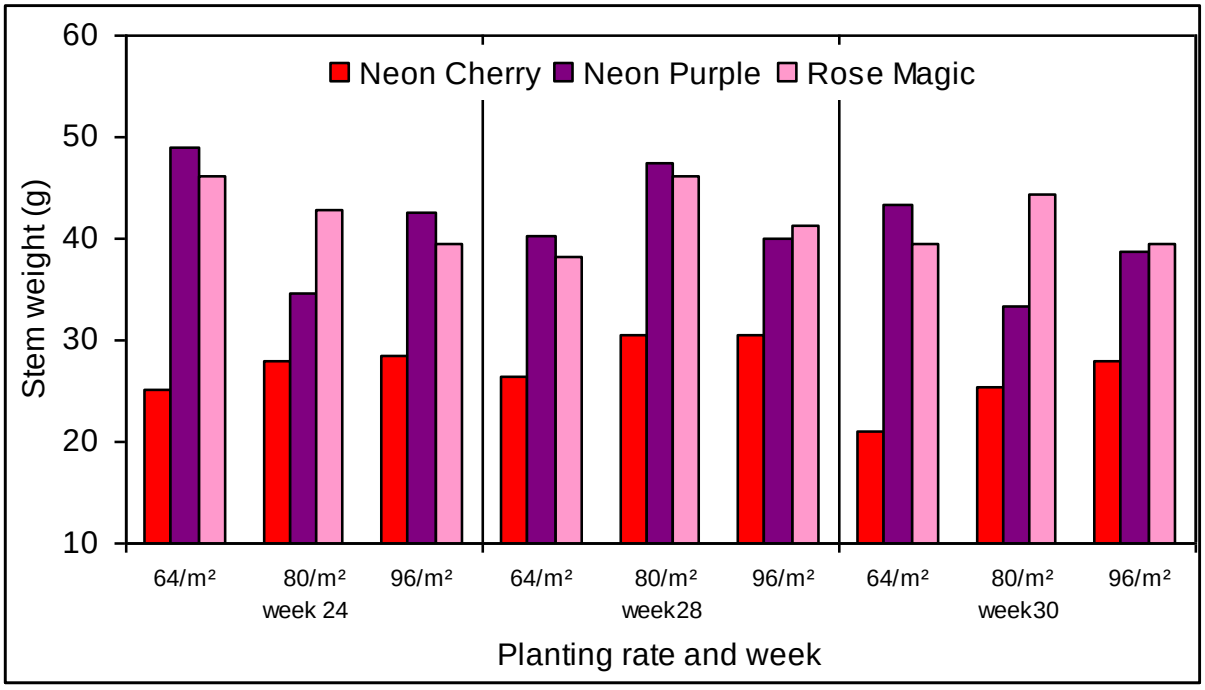

Figure 4. Annual dianthus, 2009: Stem weight

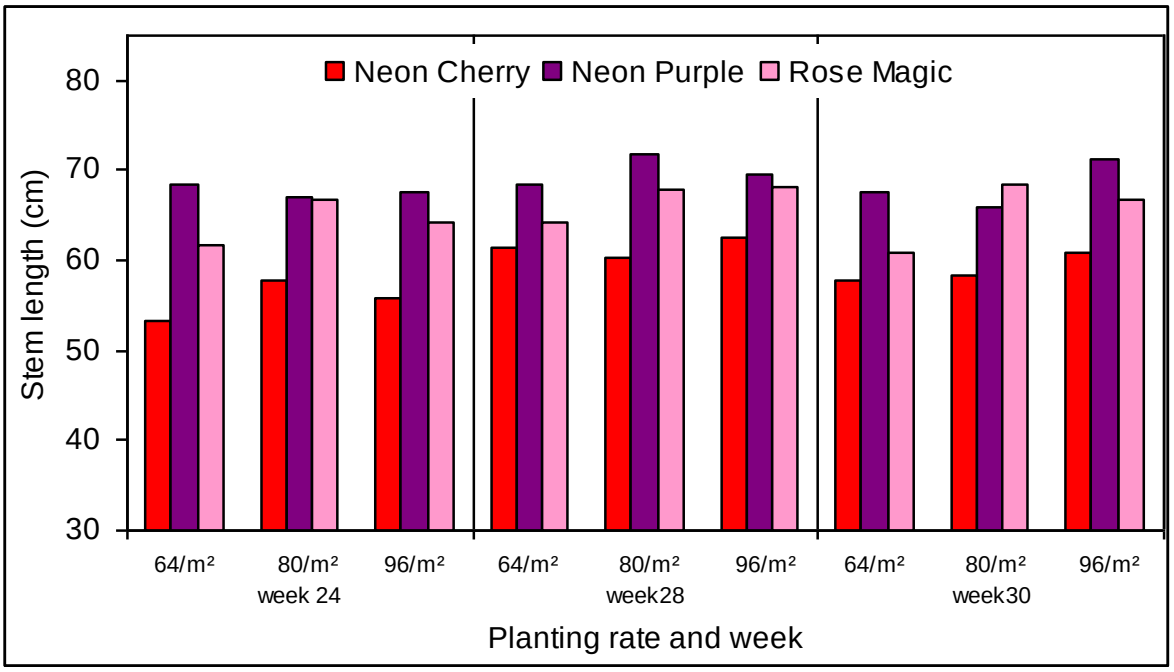

Figure 5. Annual dianthus, 2009: Stem length

Conclusions

The main conclusions from these data were as follows.

Cultivar effect 'Neon Cherry' produced more stems overall than either 'Neon Purple' or 'Rose Magic', but its stems were shorter (by about 10cm) and lighter (by about 50%) than the other cultivars, an extent that would be commercially important. 'Neon Purple' was the earliest of the three cultivars to crop, but only by about half a week, which, commercially, might be unimportant.

Planting density effect Density had no clear effects on cropping date, yield, length or weight of stems, despite the quite wide range of planting densities tested. These are vigorous plants and it appears the competitive effects of closer planting did not permit a higher yield to be taken.

Planting date effect Delaying planting from week 24 to week 28 gave an increased yield of stems, but a further delay until week 30 resulted in the lowest yield of the three, though stem weight and length were quite consistent throughout.

'Neon Purple' and 'Rose Magic' were consistent in the quality of stem produced across the different planting dates and planting densities, but yields were highest when planted at week 28. It would appear from this result that it would not be worthwhile to extend planting beyond week 28 or 29, at least under these conditions. There was no advantage in using higher planting densities. The weak response of these plants to varying the planting date and density confirmed the impressions growers reported on viewing the plots.

These trials were mirrored by evaluations on two commercial holdings, with one grower producing a crop for a UK supermarket. From these trials it became clear that the first lead stem to be produced by the plant is of much better quality (as would be expected) and is suitable for bouquet work. The side-shoots are of much lower quality than the lead stem and are only suitable for bunching. The conclusions to be drawn from these trials are therefore that for bouquet work the higher planting densities are more appropriate, but for bunching work the lower density would seem to be the most cost effective.

Table 2. Summary of crop performance for annual dianthus trial, 2009

Cultivar and planting week	Planting rate (plants/ m²)	Number of stems picked	Stem weight (g) (with SE)	Stem length (cm) (with SE)	Picking date (with SE in d)		Cropping dates		Cropping duration (d)
							First	*Last*	
'Neon Cherry'									
24	64	177	25 (1.9)	53 (1.1)	26-Aug	(0.6)	21-Aug	07-Sep	17
24	80	265	28 (1.8)	58 (0.9)	26-Aug	(0.6)	21-Aug	07-Sep	17
24	96	195	28 (1.8)	56 (1.0)	26-Aug	(0.6)	21-Aug	07-Sep	17
28	64	236	27 (1.5)	62 (1.1)	26-Sep	(1.5)	21-Sep	30-Oct	39
28	80	234	30 (1.6)	60 (1.2)	26-Sep	(1.5)	16-Sep	30-Oct	44
28	96	253	31 (1.6)	63 (0.9)	26-Sep	(1.5)	16-Sep	30-Oct	44
30	64	139	21 (1.5)	58 (1.4)	23-Oct	(1.1)	05-Oct	30-Oct	25
30	80	159	25 (1.8)	58 (1.6)	11-Oct	(1.1)	05-Oct	30-Oct	25
30	96	165	28 (1.6)	61 (1.0)	10-Oct	(1.0)	05-Oct	30-Oct	25
'Neon Purple'									
24	64	122	49 (2.5)	68 (1.7)	30-Aug	(0.6)	21-Aug	07-Sep	17
24	80	138	35 (2.1)	67 (1.3)	29-Aug	(0.6)	24-Aug	07-Sep	14
24	96	120	42 (1.8)	68 (1.4)	30-Aug	(0.5)	24-Aug	07-Sep	14
28	64	260	40 (2.9)	69 (1.3)	30-Sep	(1.3)	16-Sep	30-Oct	44
28	80	200	47 (1.9)	72 (1.1)	29-Sep	(1.4)	16-Sep	30-Oct	44
28	96	171	40 (2.1)	69 (1.2)	30-Sep	(1.4)	16-Sep	30-Oct	44
30	64	80	43 (2.9)	68 (1.4)	23-Oct	(0.6)	12-Oct	30-Oct	18
30	80	77	33 (2.0)	66 (1.0)	23-Oct	(0.6)	12-Oct	30-Oct	18
30	96	66	39 (1.4)	71 (1.0)	21-Oct	(1.1)	05-Oct	30-Oct	25
'Rose Magic'									
24	64	158	46 (2.9)	63 (1.5)	26-Aug	(0.8)	21-Aug	07-Sep	17
24	80	201	43 (2.3)	67 (1.5)	26-Aug	(0.8)	21-Aug	07-Sep	17
24	96	179	40 (2.6)	64 (1.4)	26-Aug	(0.6)	21-Aug	07-Sep	17
28	64	205	38 (2.9)	64 (1.4)	28-Sep	(1.4)	21-Sep	30-Oct	39
28	80	196	46 (2.4)	68 (1.0)	26-Sep	(1.5)	16-Sep	30-Oct	44
28	96	258	41 (2.4)	68 (1.3)	26-Sep	(1.5)	16-Sep	30-Oct	44
30	64	93	40 (3.1)	61 (1.5)	17-Oct	(1.1)	05-Oct	30-Oct	25
30	80	122	44 (1.0)	68 (1.1)	20-Oct	(1.0)	05-Oct	30-Oct	25
30	96	142	40 (2.7)	67 (1.4)	16-Oct	(1.0)	05-Oct	30-Oct	25

SE = standard error (standard deviation of the sample means)

2. DAHLIA – 'KARMA' SERIES

'Amanda'

'Bon Bini'

'Irene'

'Karma 2'

'Maarten de Zwaan'

'Naomi'

'Ventura'

'Ying Yang'

Examples of 'Karma' dahlia beds under protection and outside

Wasps on dahlia

Dahlias are considered to have a generally poor vase-life, and the 'Karma' series was developed to overcome this shortcoming. A demonstration of 18 'Karma' dahlia varieties was set up at the CFC to acquaint growers of their potential value, and, crucially, to investigate their vase-life.

Cuttings were received and planted into beds in a tunnel and outside in week 24, except that some, which were poorly rooted at receipt, were grown-on and planted later (week 26). Each cultivar occupied one 3m-long bed in the tunnel and another outside.

Two pest and disease issues arose in some cultivars as follows.

- Powdery mildew was a problem in six cultivars – 'Amanda', 'Bon Bini', 'Corona', 'Lagoon', 'Red Corona' and 'Sangria'.
- Very unusually, wasps intensively colonised the stems of a number of cultivars especially 'Bon Bini' and 'Fiesta, and in 'Bon Bini' a small number of the flowers (28 out of a total of 350 picked) were thought to have been disfigured by the resultant damage.

All plantings established well, though the outside plants were obviously inferior to those grown under protection, and detailed records were taken only from the tunnel. With the exception of 'Ying Yang', which was late to flower and produced only 13 stems by the end of the trial (week 41), all stems were picked. Thirty-five stems of each cultivar were taken at random for recording individual stem weights and lengths, and five were taken for vase-life testing.

The cropping assessments for tunnel-grown dahlias are shown in Figures 6 to 9. The average cropping date (figure. 6) showed that most cultivars were picked over weeks 36 to 38, with only 'Ying Yang' exceptional in cropping mainly in week 40.

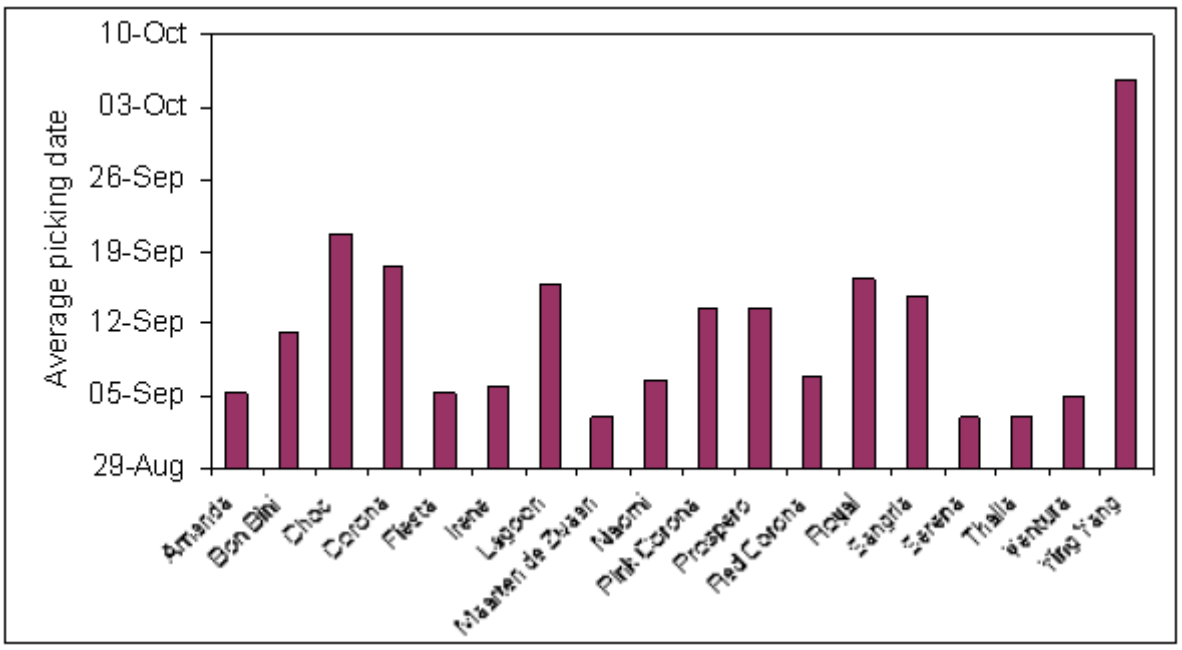

Figure 6. 'Karma' dahlia, 2009: Picking date

Excluding 'Ying Yang', the number of stems cropped for each cultivar was extremely variable, from just over 100 to over 500 per $3m^2$ plot (figure. 7).

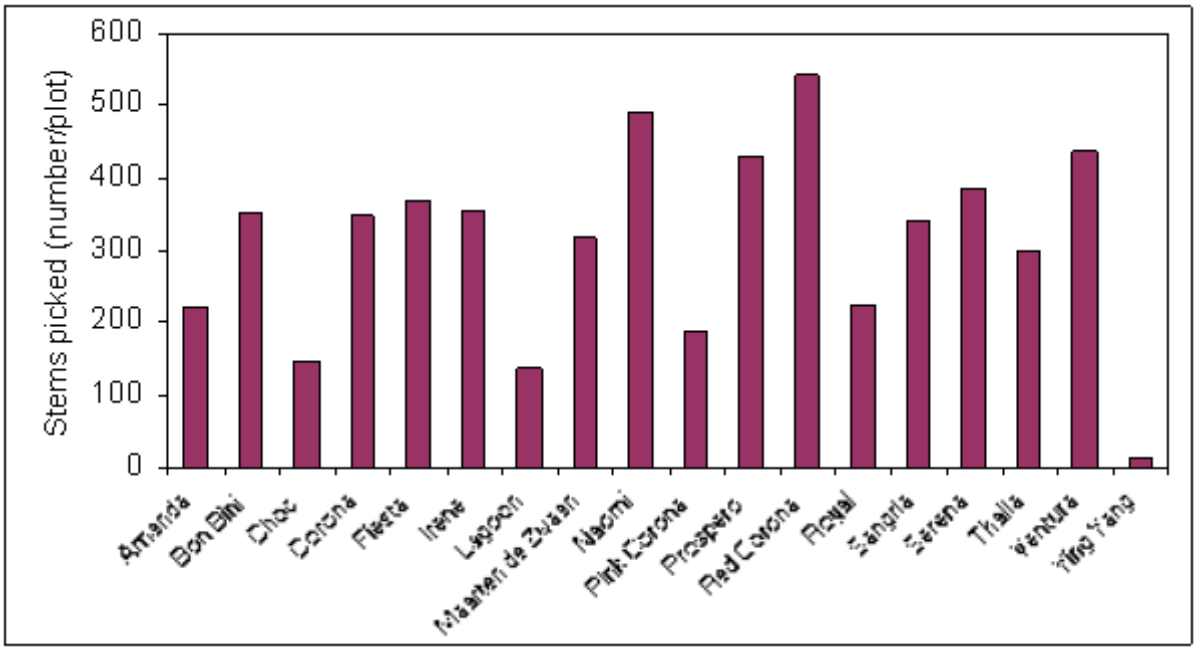

Figure 7. 'Karma' dahlia, 2009: Stem yield

Stem weight was exceptionally heavy in 'Amanda', averaging about 120g each, while in all other cultivars it ranged from 40g to 80g (figure 8). Stem length was much more consistent, with averages varying from 40cm for 'Lagoon' to 52cm for 'Ying Yang' (figure 9).

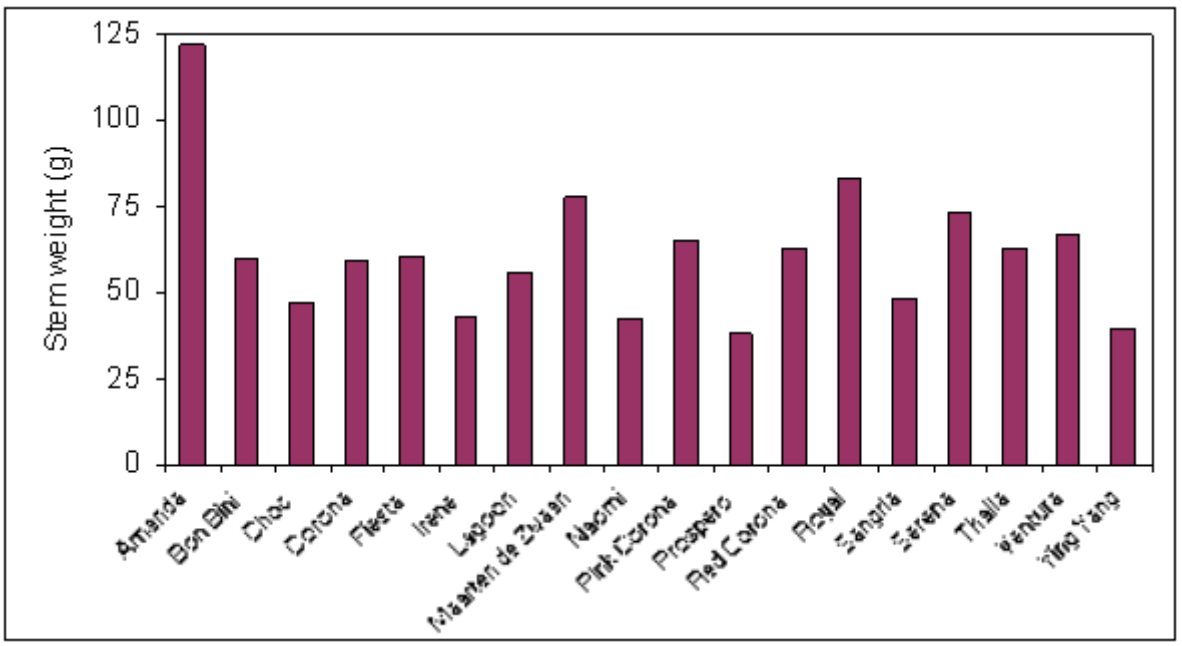

Figure 8. 'Karma' dahlia, 2009: Stem weight

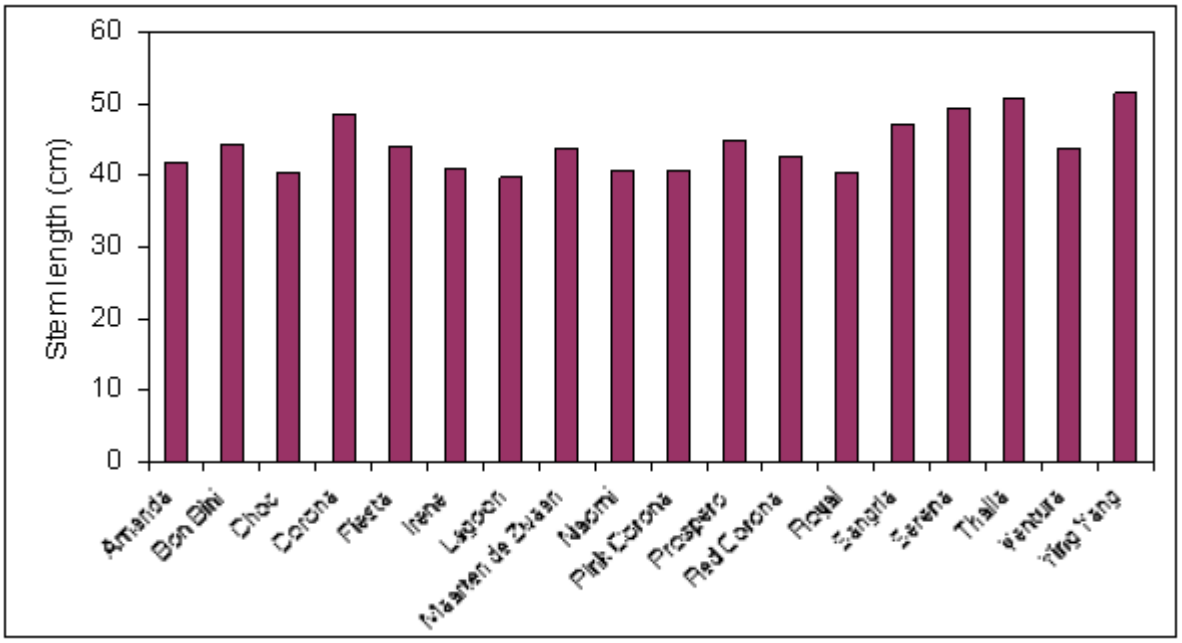

Figure 9. 'Karma' dahlia, 2009: Stem length

Vase-life tests

A series of shelf-/vase-life tests was carried out on six occasions between 3 and 29 September 2009, using material as available. Tests were run using five stems per vase, and included several tests to give was replication over time. A minimum of 11 days of shelf-/vase-life was considered necessary, to cover up to 6 days in production and retail stages plus a minimum of 5 days with the consumer. For the first test the flowers were supplied somewhat too advanced, and thereafter a picking stage with 50% of petals reflexed was aimed for.

Various combinations of post-harvest and vase treatments were tested, involving nearly 250 individual vases. Tests were begun with a comparison of treatment in 'Chrysal' CPC2 followed by treatment in 'Chrysal' universal flower food, with a control in water throughout. In later tests the post-harvest treatments included 'Chrysal' CVBn, RVB, BVB followed by RVB (at various strengths), with bulb flower food or universal flower food (at full- or ½-strength) used in the consumer phase.

In every case the stems failed to reach the target 11-day total shelf-/vase-life required. The foliage had generally wilted or browned by day 6 or 7, with petals wilted by day 7 or 8 or, occasionally, day 9. Whilst the use of one or more of the flower conditioner/flower food treatments resulted in an extension in shelf life of about 1 day compared with controls in water, shelf life remained well below the 11 days realistically required for commercial

production. There was no consistency as to which of the various treatments lead to this slight delay.

Conclusions

This demonstration of 'Karma' dahlia cultivars elicited a very encouraging response from many who visited the trials site – they created great visual impact and stems were strong and colourful, though those grown in the tunnel were by far superior. Except for one of the 18 varieties they produced high, if variable, numbers of marketable stems within a reasonable period, with average picking dates mostly between week 36 and 38, following planting in weeks 24 or 26. Achieved stem length at harvest was suitably consistent at 40 to 50 cm across the planting dates assessed. However, stem yield and weight were variable, and careful varietal selection for these factors would be required.

Six of the 18 cultivars grown were affected by powdery mildew. In future this should be controllable, given the knowledge of susceptibility. The intense colonisation of the stems of two of the varieties by wasps was an unexpected occurrence and evidently an unusual one.

Despite other excellent qualities, the vase-life of these dahlias was disappointing. Although tests were repeated, and a range of post-harvest and vase-life solutions was used, the total shelf/vase-life of these stems never approached the total of 11 days deemed necessary for commercial acceptance. Unless this can be rectified e.g. using other cultivars and (or) post-harvest treatments, it is difficult to see how 'Karma' dahlias could be taken forward as a commercial cut-flower. A brief literature review (Appendix 1) highlighted that a number of attempts have been made to improve vase-life of dahlia, and there may be scope for other flower treatments to be trialled: the problem could be referred to a flower-food manufacturer for comments.

3. GERMAN ASTERS

Following considerable interest in these attractive and productive new varieties of China aster at the CFC and on a commercial nursery in 2008, a further trial was set up to investigate the effects of:

(a) Planting density
(b) Planting date
(c) Pinching
(d) 'Double-cropping'.

Plug-plants of asters 'Gala Lavender', 'Krallen Golden' and 'Krallen Kameo' were transplanted into beds in a tunnel on several dates (weeks 24, 26, 28, 30 and 31) at three planting densities (32, 48 and 64plants/m^2), as summarised in the following table:

Density (plants/m²)	**Planting week**				
	24	**26**	**28**	**30**	**31**
Krallen Golden					
32	√	√	√		
48	√	√	√		
64	√	√	√		
Krallen Kameo					
32	√	√	√	√	
48	√	√	√	√	
64	√	√	√	√	
Gala Lavender					
32			√		√
48			√		√
64			√		√

For each treatment combination of Gala Lavender a single 3m-long bed was planted, and for the cultivars 'Golden' and 'Kameo', each treatment combination occupied a half bed plot. Most plantings needed some gapping-up, mainly due to plants being dislodged when wind lifted the polythene mulch, but otherwise they established well and grew without significant

problems, other than symptoms suggesting tomato spotted-wilt virus (TSWV) and impatiens necrotic spot virus (INSV) as illustrated below. TWSV and INSV damage was considered probably due to an unusual, chance infection by the vector, western flower thrips (WFT) (T.J.O'Neill, personal communication); it indicated a requirement for appropriate control measures when growing this crop.

All stems were cropped and about 35 stems, as available, were taken at random and used for detailed recording. Those plants showing virus symptoms were excluded when calculating average picking dates and stem weights and lengths.

1. <u>The effect of planting density and planting date in 'Golden' and 'Kameo'</u>

Cultivars 'Golden' and 'Kameo' were transplanted at densities of 32, 48 and 64 plants/m^2 in weeks 24, 26 and 28, with duplicate plots of each treatment combination. The total number of stems picked is shown in figure 10. For both cultivars, stem yields increased with increasing planting rates, but there was no effect of planting date on yield. 'Golden' was slightly more productive than 'Kameo'.

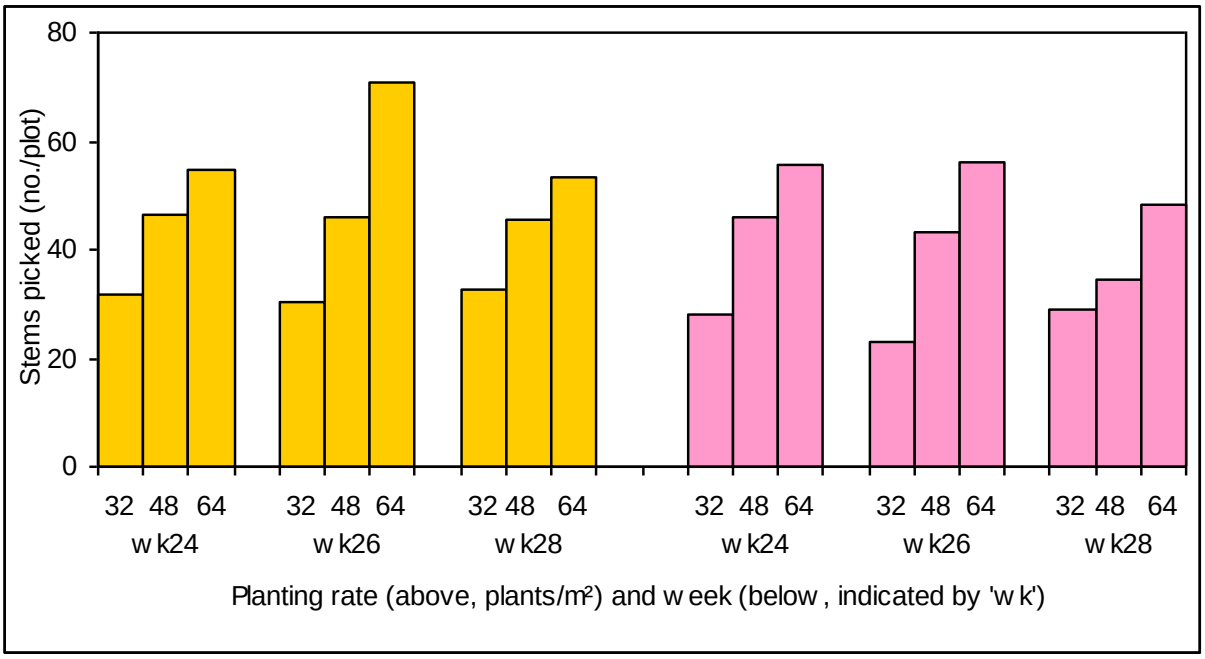

Figure 10. Effects of planting date and rate on asters 'Golden' (gold blocks on left) and 'Kameo' (rose blocks on right), 2009: Total number of stems picked

'Kameo' was consistently around one week earlier to picking than 'Golden'(figure 11). Using higher planting density consistently delayed picking, but by a commercially insignificant amount.

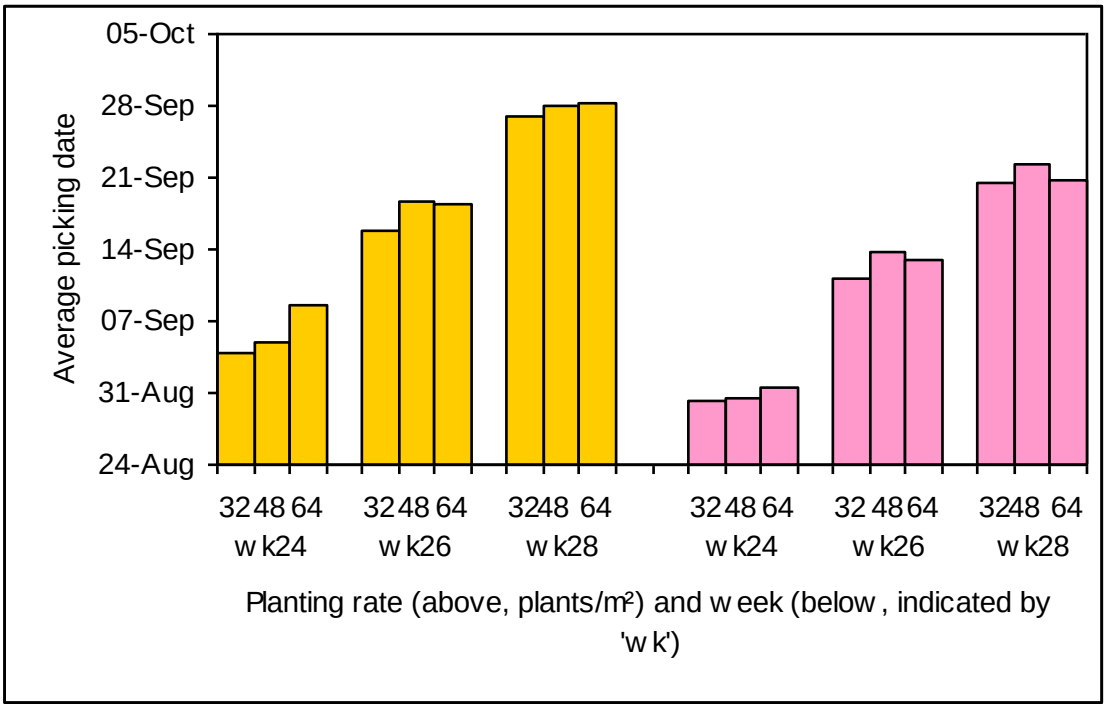

Figure 11. Effects of planting date and rate on asters 'Golden' (left) and 'Kameo' (right), 2009: Average picking date

Stem weight (figure 12) fell progressively with later planting and higher planting densities, while stem lengths (figure 13) fell slightly with later planting dates but were hardly affected by planting density. Overall, stems of 'Golden' were a little heavier than those of 'Kameo', but any effects on stem length were slight.

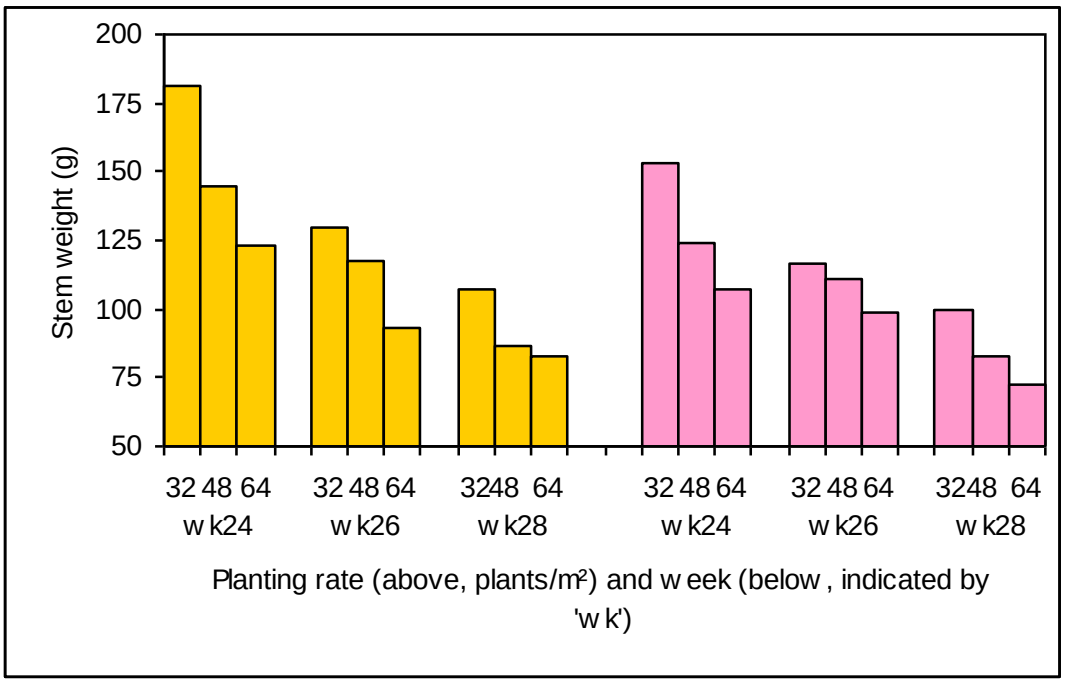

Figure 12. Effects of planting date and rate on asters 'Golden' (left) and 'Kameo' (right), 2009: Average stem weight

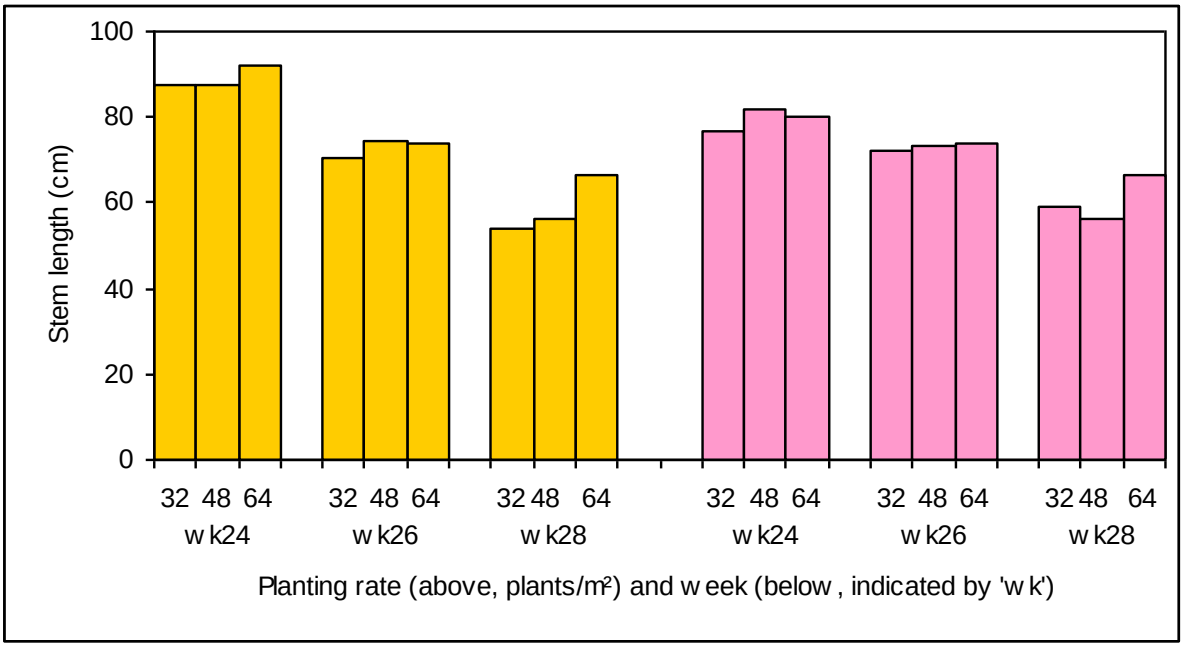

Figure 13. Effects of planting date and rate on asters 'Golden' (left) and 'Kameo' (right), 2009: Average stem length

In this trial there was a significant number of plants with symptoms of TSWV and INSV as illustrated in the photographs below. Cultivar 'Kameo' was markedly more susceptible than 'Golden', and plants from all planting dates were affected (figure 14).

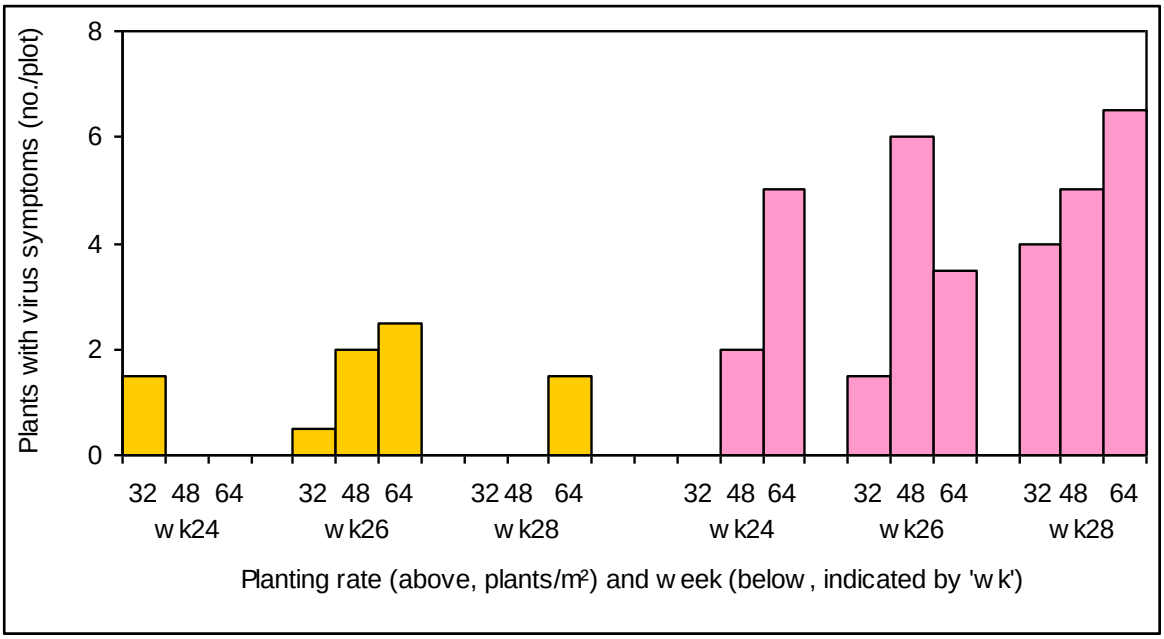

Figure 14. Effects of planting date and rate on asters 'Golden' (left) and 'Kameo' (right), 2009: Numbers of plants showing virus symptoms

Examples of German asters showing viral symptoms

Cultivar effect: 'Golden' produced more and heavier stems than 'Kameo', while 'Kameo' was about a week faster on average to picking. 'Kameo' appeared to be more susceptible to viral infections than 'Golden'.

Planting density effect: As planting density increaseed, stem yield increased, stem weight fell, and cropping was slightly delayed.

Planting date effect: Stem weight (and stem length, slightly) fell with later planting.

2. <u>The effect of planting density and planting date over an extended range of planting dates and cultivars</u>

This section uses the same data as above, with the addition of cultivar 'Gala' planted in weeks 28 and 31 and 'Kameo' planted in week 30 to extend the range of varieties and planting dates. Not all the extra treatments were based on replicated plots, owing to shortages of plants.

The results (Figs 15–19) from these extra plantings confirmed the results already described in the section above.

- The total number of stems picked increased as planting density increased. The later plantings of Gala and Kameo were planted in the full 3m of bed (earlier Krallen beds were split between Golden and Kameo) which explains the higher yields per plot shown at Fig 15)
- The decrease in average stem weight with later plantings and higher planting rates.
- The decrease in average stem length with later plantings.

Virus infection also occurred in later plantings and in 'Gala'.

As would be expected, the lower density produced heavier stems, with stems at 32 plants/m^2 being approximately 26 to 40% heavier that those grown at 64 plants/m^2. However, most stems grown at the higher density of 64 plants/m^2 still produced stems heavy enough to meet the current supermarket specifications, so there is little commercial advantage in planting at lower densities unless the crop is being grown for a high specification outlet. Planting density did not have any significant effect on stem length.

In a previous trial in 2007, 'Gala' and 'Krallen' were found to be the most promising of the German aster varieties available at the time. The 2009 trials demonstrated that 'Krallen' maintained an adequate head size throughout all of the planting dates, but the late planting of 'Gala' did not give a sufficiently large head to differentiate it from the 'Matsumoto' series. This variety trial work will be further investigated in 2010.

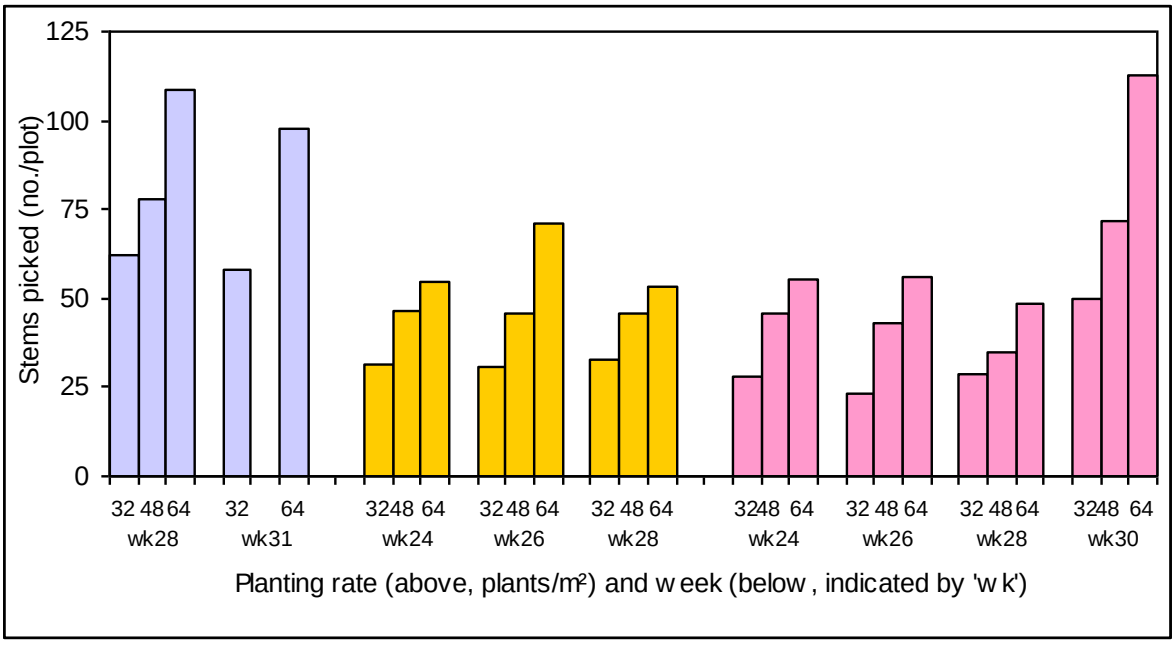

Figure 15. Effects of planting date and density on asters 'Gala' (lavender blocks, left), 'Golden' (gold blocks, centre) and 'Kameo' (rose blocks, right), 2009: Total stems picked (where there is no axis-label for planting density, this treatment combination was not included)

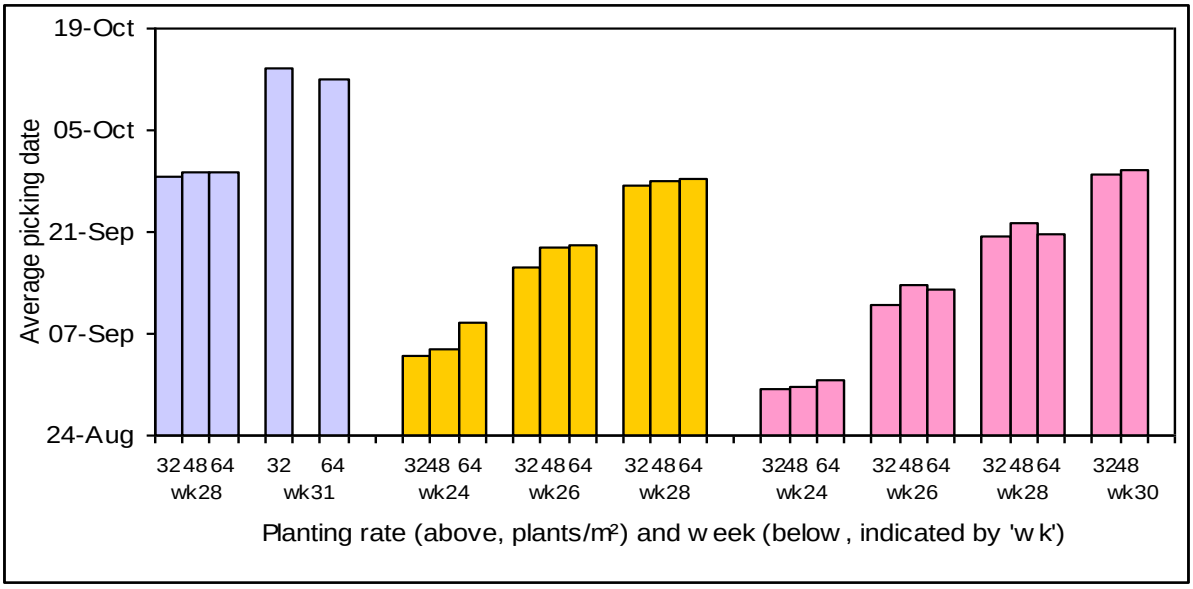

Figure 16. Effects of planting date and density on asters 'Gala', 'Golden' and 'Kameo', 2009: Average picking date (see Figure 15)

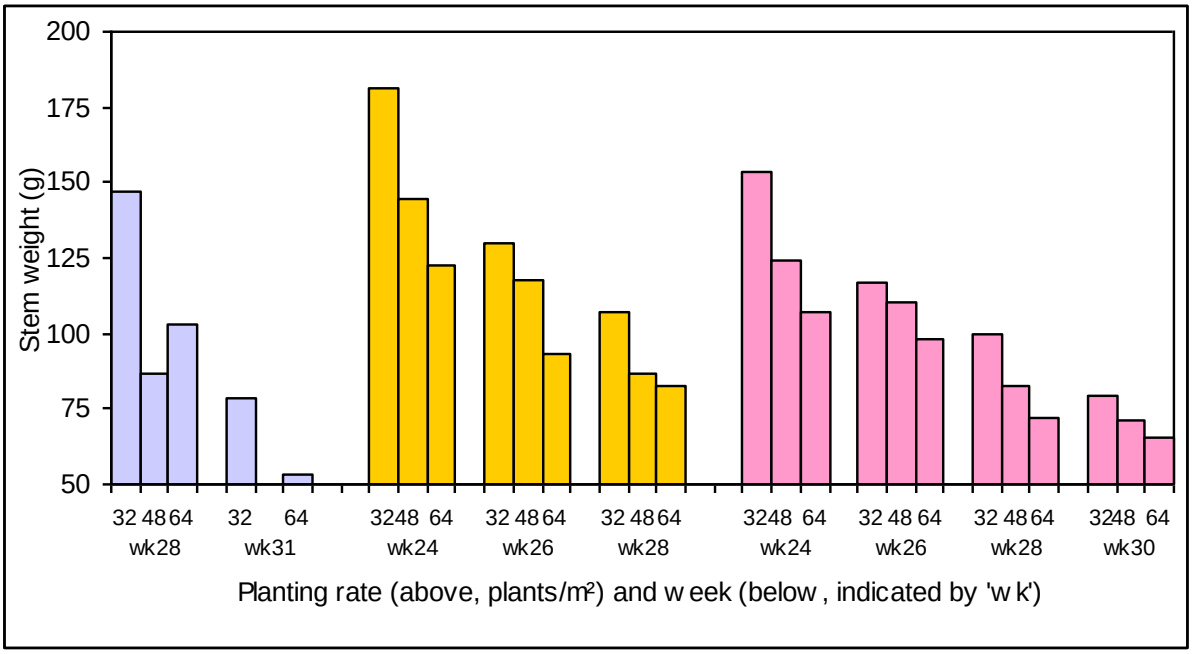

Figure 17. Effects of planting date and density on asters 'Gala', 'Golden' and 'Kameo', 2009: Average stem weight (see Figure 15)

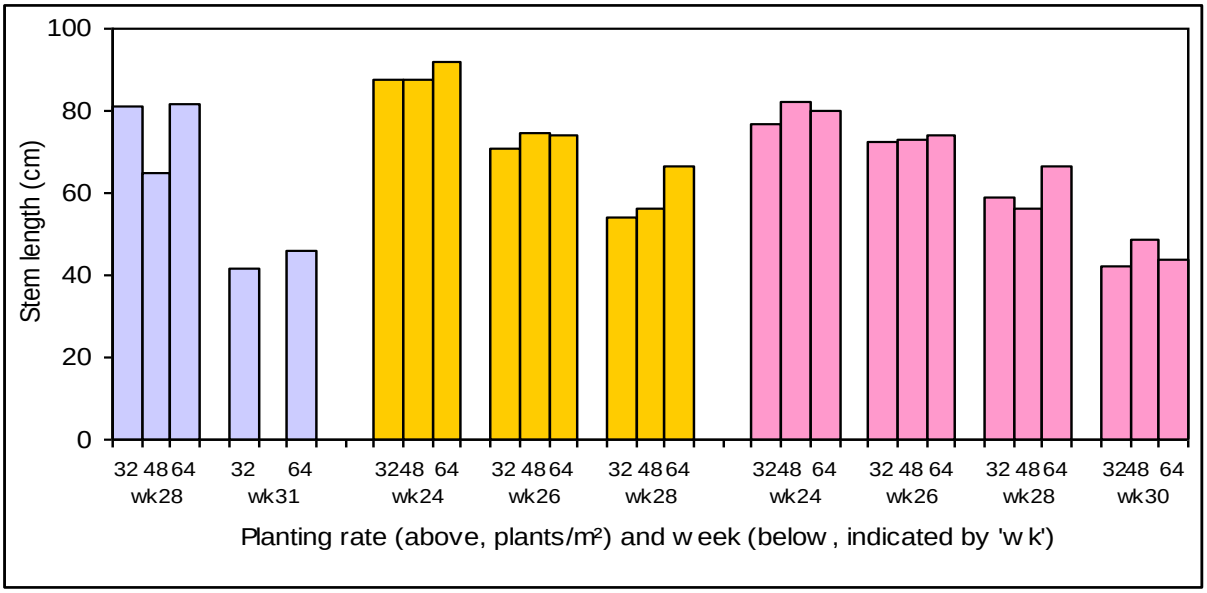

Figure 18. Effects of planting date and rate on asters 'Gala', 'Golden' and 'Kameo', 2009: Average stem length (see Figure 15)

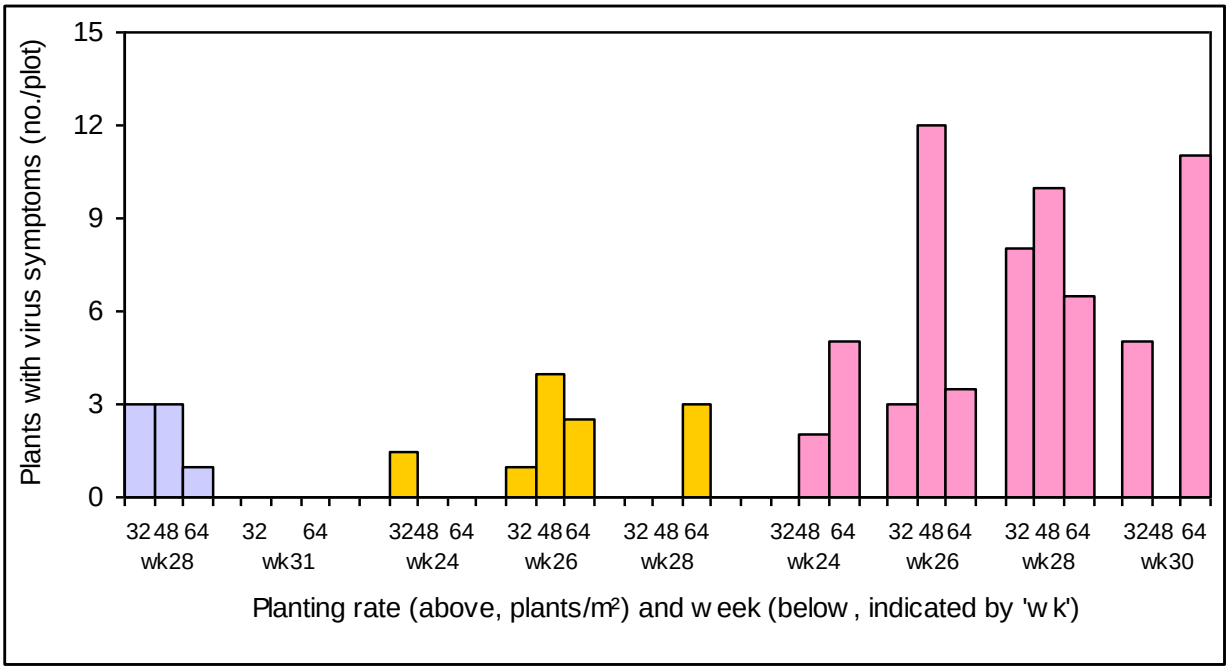

Figure 19. Effects of planting date and rate on asters 'Gala', 'Golden' and 'Kameo', 2009: Numbers with viral symptoms (see Figure 15; where there is an axis-label and no block, the value was zero)

3. The effect of pinching (stopping)

To determine the effects of pinching, plots of 'Gala', 'Golden' and 'Kameo', planted from week 28 to 31, were either pinched or left un-pinched as controls. A plot from each planting date and density was pinched to three or four leaves within 2 weeks of planting, as with natural-season chrysanthemums, with the expectation that they would produce three or four breaks per plant.

The results (Figs 20–23) showed that there appeared to be little advantage in pinching, which confirmed the views of growers visiting the trials. Compared with un-pinched controls, pinching plants gave:

- In 'Kameo', an increase in the total number of stems picked, while the results for 'Gala' and 'Golden' were inconsistent
- Stems of markedly lower average weight and length, overall
- Later cropping (by about half a week).

Pinching was therefore generally not successful with these varieties. The results varied, with some plants producing a 'gall-like' callus but not shoots, others throwing a new lead shoot with no breaks, and some throwing very weak shoots which did not produce marketable stems. Hence none of the pinched plots ultimately produced any marketable stems from any of the planting dates, density or variety.

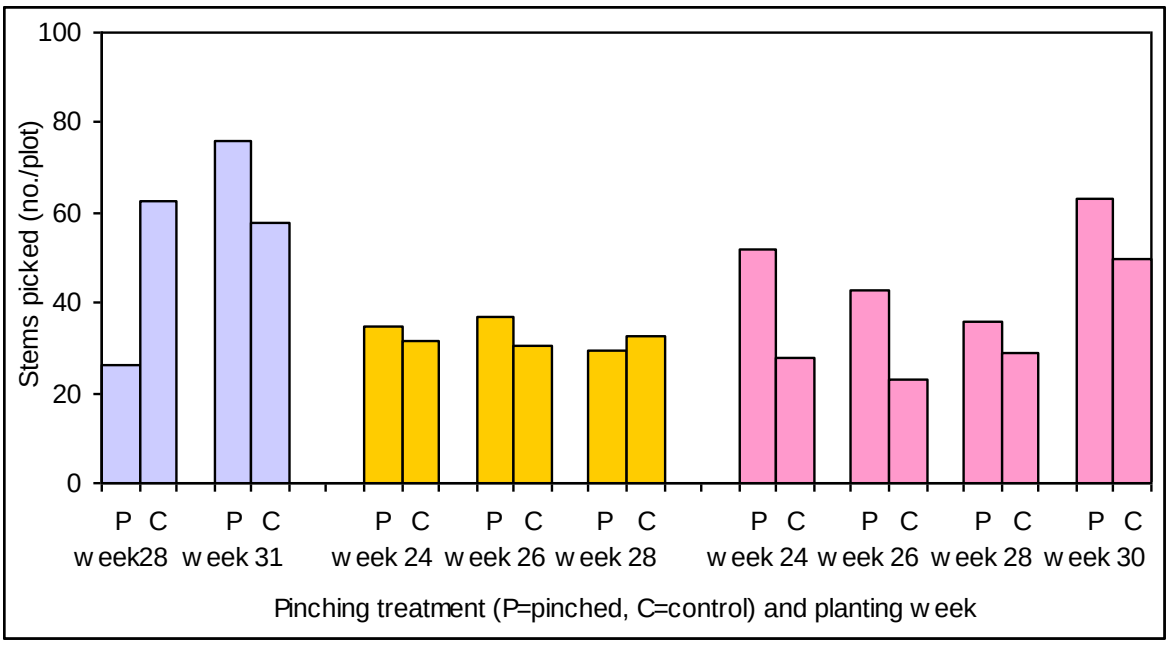

Figure 20. Effects of pinching (P) or not (control, C) on asters 'Gala' (lavender blocks, left), 'Golden' (gold blocks, centre) and 'Kameo' (rose blocks, right) planted at different dates, 2009: Total number of stems picked

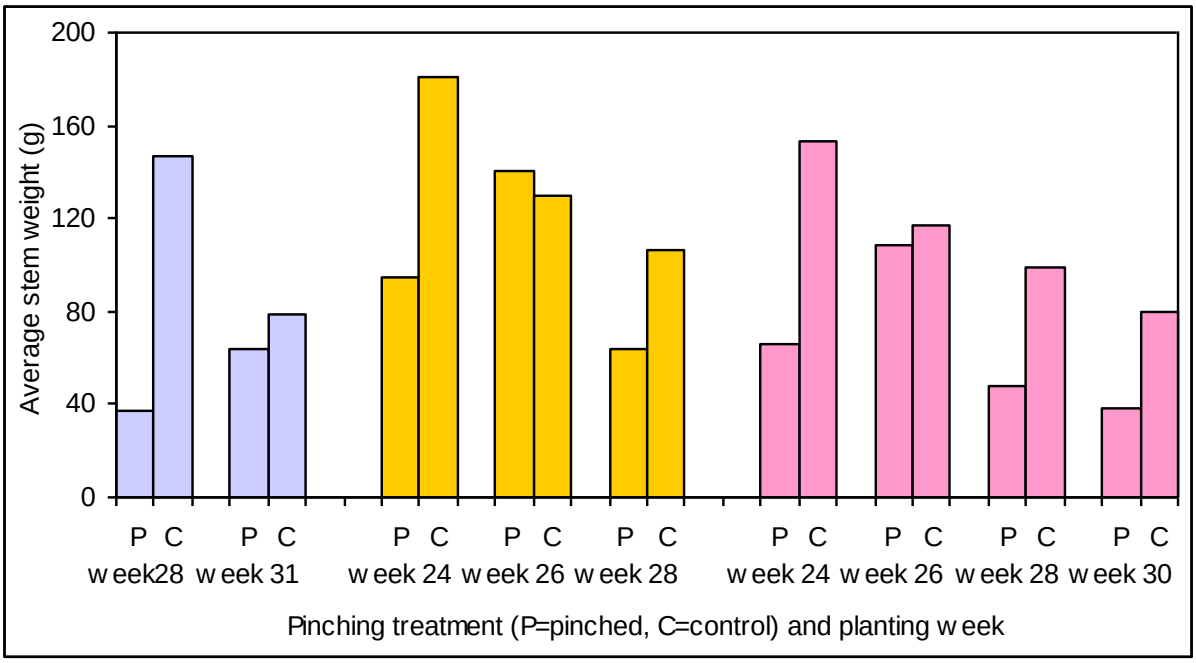

Figure 21. Effects of pinching (P) or not (control, C) on asters 'Gala', 'Golden' and 'Kameo' planted at different dates, 2009: Average weight of stems (see Figure 20 for further details)

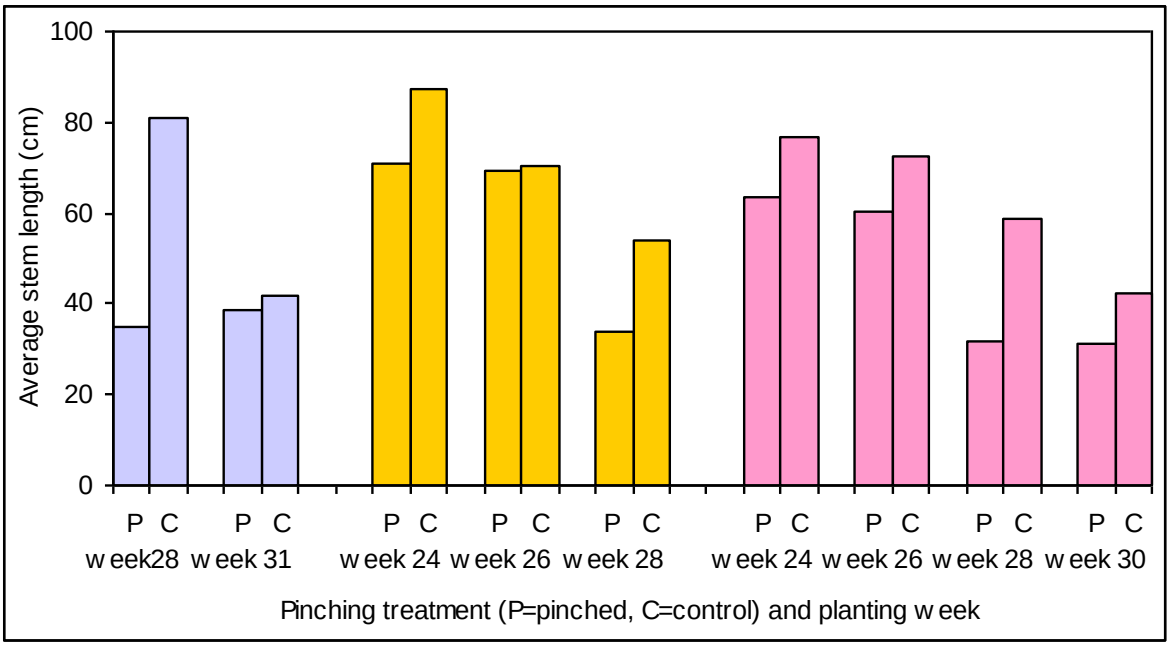

Figure 22. Effects of pinching (P) or not (control, C) on asters 'Gala', 'Golden' and 'Kameo' planted at different dates, 2009: Average length of stems (see Figure 20 for further details)

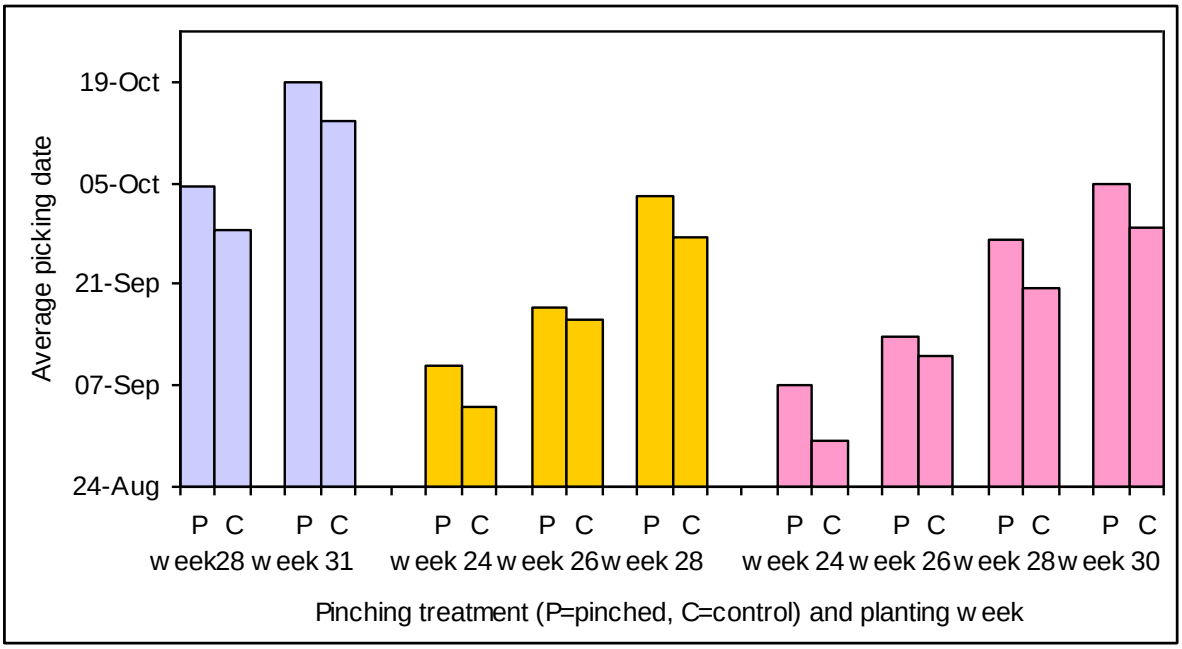

Figure 23. Effects of pinching (P) or not (control, C) on asters 'Gala', 'Golden' and 'Kameo' planted at different dates, 2009: Average picking date (see Figure 20 for further details)

4. <u>The effect of 'double-cropping'</u>

In 'double-cropping' the lead stem is picked, followed by the side stems later rather than picking the lead shoot and side shoots at the same time. To determine the effects of this treatment, plots of 'Gala' (planted week 28) and 'Golden' and 'Kameo' (planted weeks 24, 26 and 28), all planted at rates of 32, 48 and 64/m^2, were either 'double-cropped' or picked conventionally.

For double-cropped plots, in the earlier plantings side-shoots were picked as they were ready. For plantings in week 28, following the picking of the central stem, side-shoots were picked together as a complete stem at an appropriate date. In the latter case, the number and length of side-shoots were recorded from a sample of 10 plants per plot.

The results are summarised in Table 3. The effects of 'double-cropping' on stem production were as follows.

- In all cultivars and at all planting rates, double-cropping greatly reduced weight and length of the harvested lead stem.
- In 'Gala' (only planted at week 28) double-cropping generally resulted in more stems, but the increase in numbers was not dramatic.

- In 'Golden', double-cropping produced vastly more stems from the week 24 and 26 plantings, but when planted at week 28 the effect of double-cropping was small and inconsistent.
- In 'Kameo', double-cropping led to many more stems being picked, though when planted in week 28 the effect was much weaker.
- In general double-cropping had little effect on average picking date, usually less than a week.
- Side-shoots of 'Gala' averaged 3.5 stems per plant, with an average length of 34.5cm. In 'Golden' and 'Kameo' the number of side-shoots per plant averaged 4.3 per plant and they were longer in 'Kameo' (average, 43.3cm) than in 'Golden' (28.3cm).

Double-cropping produced many more stems, but these were too short and (or) too weak, and did not meet the required supermarket specifications. Single-stem production seems to be the most appropriate technique to produce the current German aster specification required by UK supermarkets. However, the 2009 trial also investigated the possibility of double-cropping using two different techniques. The first option was to crop all of the side-shoots separately and amalgamate them into a bunch. The second option was to remove the lead side-shoot when it matured and then allow the side-shoots to mature before harvesting the remaining shoots as a complete stem. Neither of these techniques produced a product that was of a suitable specification for UK supermarkets, but could possibly be sold via outlets that want a 'bunched' crop. The first technique produced short, weak stems. Using the second technique, once the lead stem was removed, the remaining stem was of a suitable length and weight; however, it did not look attractive in the sleeve because the flower-heads were at different heights and were borne on weak stems.

Table 3 Summary of crop performance under double- and conventional cropping for German asters trial in 2009

Cultivar and planting week	Planting rate (plants/m²)	Cropping treatment	Total no. of stems picked	Main stems			Side-shoot sample	
				Stem weight (g)	Stem length (cm)	Picking date	No. per plant	Length (cm)
'Gala'								
28	32	Double	61.5	29	39	01-Oct	3	25
		Control	62.5	147	81	28-Sep		
28	48	Double	90.0	54	53	29-Sep	4	44
		Control	78.0	87	65	29-Sep		
28	64	Double	143.0	25	44	28-Sep	0	0
		Control	108.5	103	81	29-Sep		
'Golden'								
24	32	Double	183.0	21	46	13-Sep		
		Control	31.5	181	88	03-Sep		
24	48	Double	262.0	21	48	06-Sep		
		Control	46.5	145	87	04-Sep		
24	64	Double	283.0	17	45	14-Aug		
		Control	54.5	123	92	08-Sep		
26	32	Double	103.0	42	55	19-Sep		
		Control	30.5	130	71	16-Sep		
26	48	Double	177.0	26	51	19-Sep		
		Control	46.0	117	74	18-Sep		
26	64	Double	286.0	33	48	20-Sep		
		Control	71.0	93	74	19-Sep		
28	32	Double	56.0	38	34	01-Oct	5	26
		Control	32.5	107	54	27-Sep		
28	48	Double	56.0	45	39	02-Oct	4	26
		Control	45.5	87	56	28-Sep		
28	64	Double	36.0	31	42	28-Sep	4	33
		Control	53.5	83	66	28-Sep		
'Kameo'								
24	32	Double	184.0	24	51	06-Sep		
		Control	28.0	153	77	30-Aug		
24	48	Double	na	na	na	na		
		Control	46.0	124	82	30-Aug		
24	64	Double	283.0	17	45	14-Aug		
		Control	54.5	123	92	08-Sep		
26	32	Double	61.0	38	51	12-Sep		
		Control	23.0	117	72	11-Sep		
26	48	Double	110.0	39	58	15-Sep		
		Control	43.0	111	73	13-Sep		
26	64	Double	101.0	42	53	13-Sep		
		Control	56.0	98	74	13-Sep		
28	32	Double	55.0	37	37	23-Sep	4	36
		Control	29.0	99	59	20-Sep		
28	48	Double	81.0	40	48	21-Sep	4	46
		Control	34.5	82	56	22-Sep		
28	64	Double	92.0	44	53	21-Sep	4	48
		Control	48.5	72	66	20-Sep		

na, not available, this treatment combination not done

Conclusions

- As would normally be expected, the number of stems increased as the density of planting was increased, while stem weight fell and picking was (slightly) delayed.
- Stem weight and length fell with later planting.
- 'Golden' produced more and somewhat heavier stems than 'Kameo', while 'Kameo' was about a week faster on average to picking than 'Golden'.
- Plants in all varieties and planting dates evidenced infection by TSWV and INSV; 'Kameo' appeared to be more susceptible than 'Golden'.
- Little advantage was attributed to pinching crops. Pinching resulted in stems of lower weight and length and later cropping.
- Double-cropping produced many more stems, but these were of poor quality and did not meet the required specifications for stem length and (or) strength.

4. PHLOX

Plots of seven phlox varieties grown at Kirton were dug and transplanted to Rookery Farm after a period of cold storage. The plants established well, and were grown-on to assess their flowering potential in the third year.

The seven cultivars were highly variable in productivity. 'Sugar Missy' was outstanding in terms of flower production (74/m^2), while the lowest stem yield was in 'Magical Surprise' (7/m^2) (Figure 24). Average picking date varied from 15 July ('Miss Fiona') to 11 August ('Magical Surprise') (Figure 25).

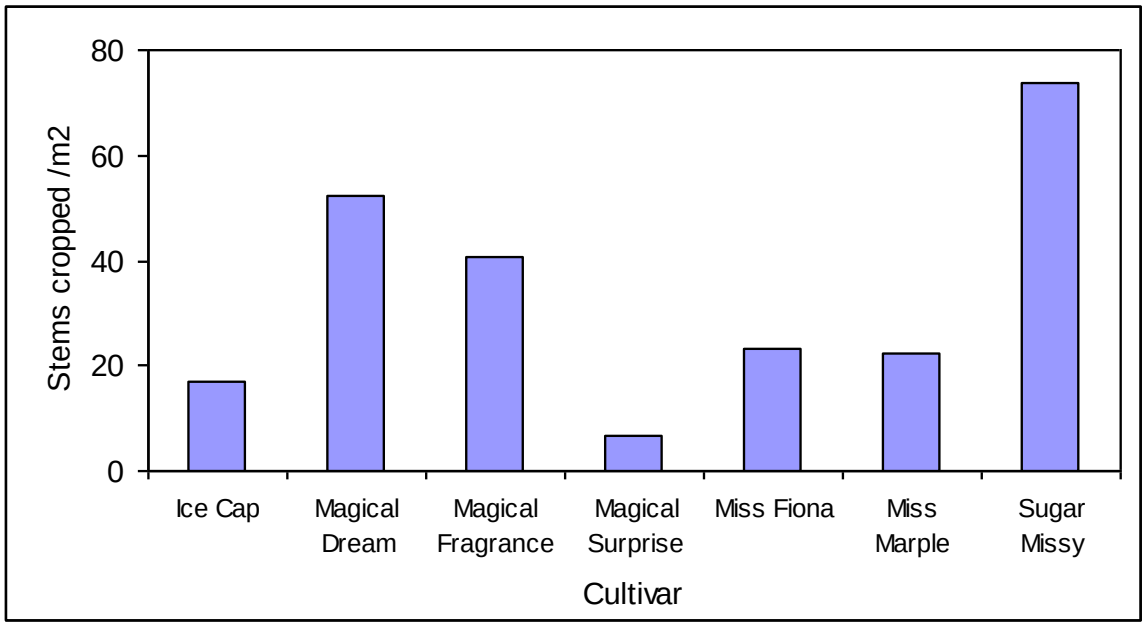

Figure 24. Stem yield in phlox cultivars in their third year, 2009

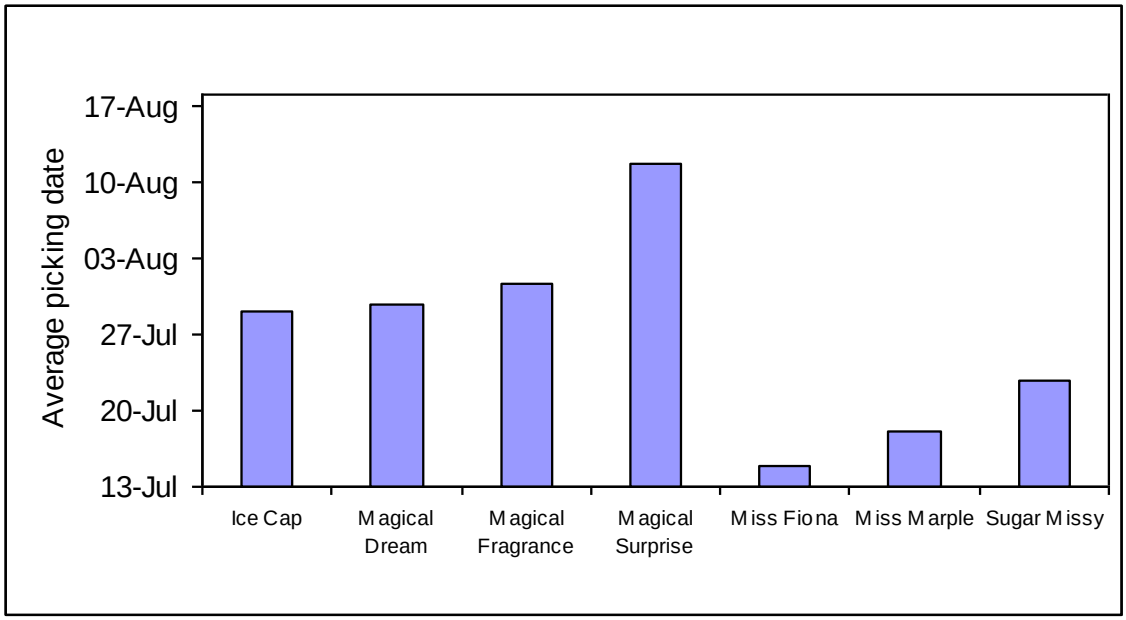

Figure 25. Average picking date in phlox cultivars in their third year, 2009

'Ice Cap', 'Miss Fiona' and 'Sugar Missy' produced the longest and heaviest stems (Figs 26 and 27).

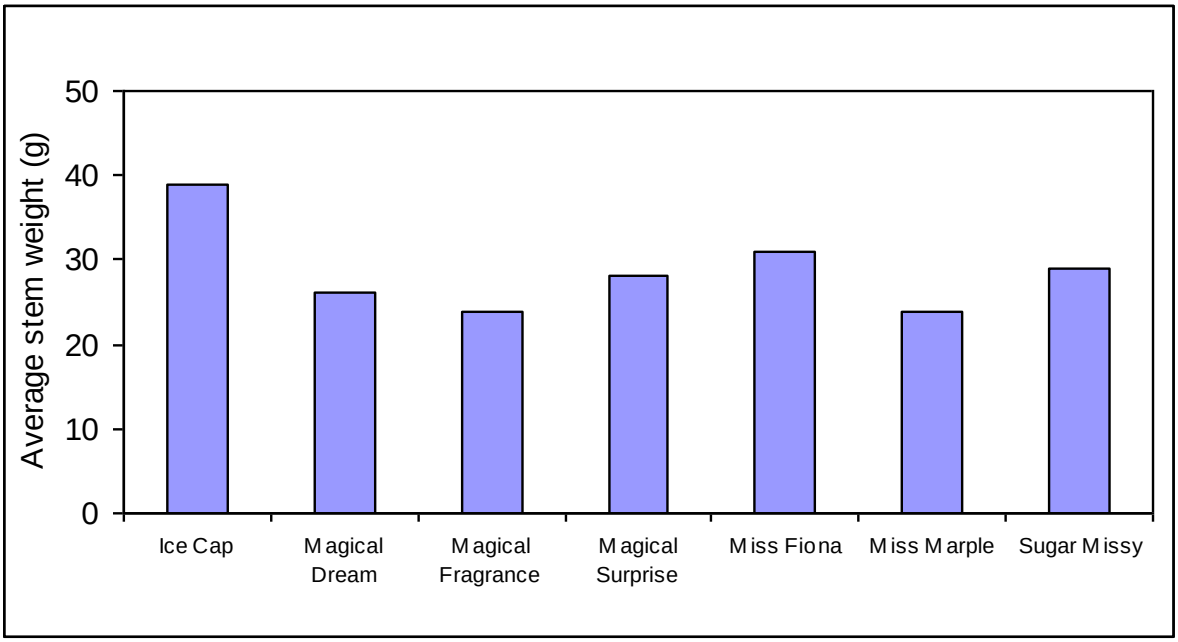

Figure 26. Stem weight in phlox cultivars in their third year, 2009

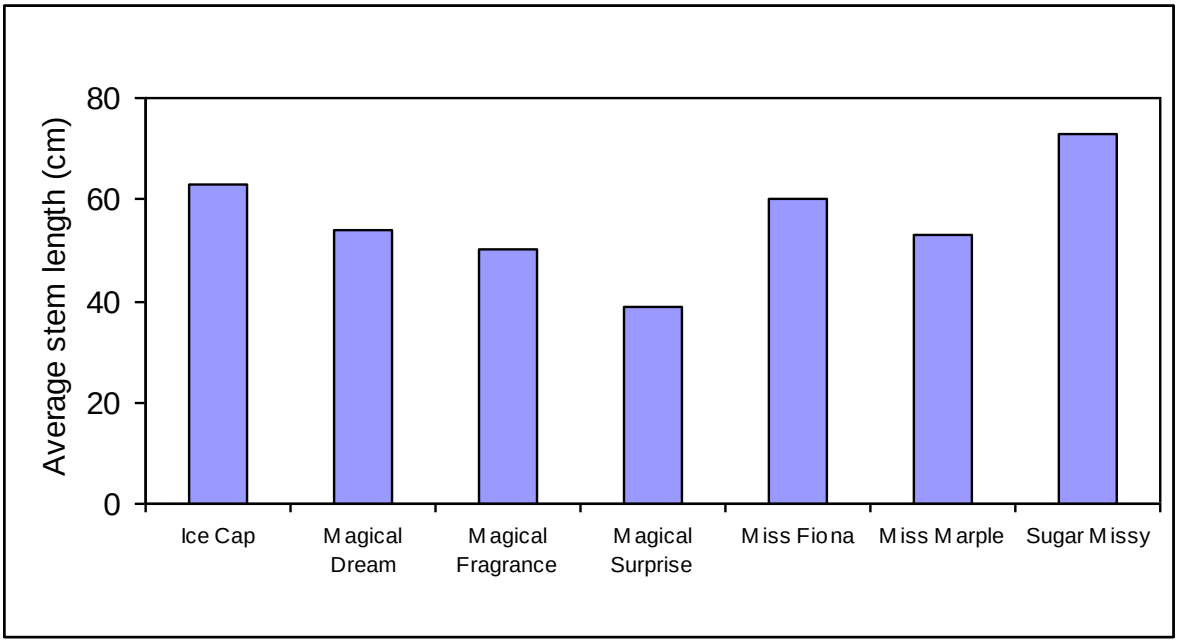

Figure 27. Stem length in phlox cultivars in their third year, 2009

Vase-life tests

Samples of phlox were evaluated in three shelf-/vase-life tests carried out between 24 July and 11 August 2009, involving 20 vases in all and using material as available. In general a vase of ten or more stems was tested for each cultivar. A minimum of 11 days of shelf-/vase-

life would be required, to cover up to 6 days in production and retail stages, plus a minimum of 5 days with the consumer. For the first test the flowers were supplied dry, and thereafter they were supplied in 'Chrysal' CVBn post-harvest solution. For the store phase (6 days from picking) the stems were placed in CVBn, thereafter in 'Chrysal' universal flower food for the consumer (vase) phase. Vases were deemed to be at the end of their life when 50% or more of the flowers had died.

The results of evaluations are summarised in Table 4. By day 11, both samples of 'Ice Cap' had more than half the florets dead, vase-life having ended on day 8-9. All other samples tested exceeded their required 11 days total shelf-/vase-life, with between 5 and 40% of florets dead at day 11. Two samples exhibited yellowing foliage by day 11. Total vase-life was highly variable, but very long in some cases, between 12 and 21 days. These results are encouraging, but need to be confirmed using larger sample numbers.

Table 4. Vase-life evaluation of phlox cultivars

Test	Cultivar	Percentage of florets unopened/open/dead on day 11, and other comments	Total vase-life (days)
1	Ice Cap	0/20/80	8
1	Sugar Missy	0/95/5	20
1	Magical Dream	0/90/10	15
1	Miss Marple	10/60/30	13
1	Magical Fragrance	20/60/20	12
1	Miss Fiona	20/50/30	13
2	Ice Cap	0/40/60	9
2	Sugar Missy	0/90/10	18
2	Magical Dream	0/80/20	13
2	Magical Fragrance	20/50/30	12
2	Miss Fiona	10/70/20	16
3	Sugar Missy	0/70/30, yellowing foliage	21
3	Miss Marple	40/20/40, yellowing foliage	12
3	Miss Fiona	0/90/10	19

Conclusions

'Sugar Missy' was relatively early, and produced the greatest number of stems, with the greatest length and a reasonable weight. It had the longest vase-life, 18 to 21 days over three tests, but there was yellowing foliage by day 11 in one out of three samples.

'Magical Dream' and 'Magical Fragrance' gave good numbers of stems, and had average picking dates and stem weight and length. They had vase-lives of 12 to 15 days over different tests. They also showed remarkable resistance to powdery mildew in 2009.

'Ice Cap' produced lower yields and was 'mid-season', had the heaviest stems and long stems, but its vase-life was well below 11 days. This requires further investigation because it is one of the best whites currently available as regards stem strength and length.

'Miss Fiona' and 'Miss Marple' also produced lower yields, but were early, with long, heavy stems and vase-lives that varied between 12 and 19 days in different tests.

'Magical Surprise' was the latest flowering variety and consequently yielded fewest stems within the period of the trial. Stem weight was average but stem length was relatively low. It produced insufficient stems for vase-life testing.

Clearly, some phlox varieties show potential for useful production rates with good vase-lives. Further cultivar comparisons may be worthwhile.

OTHER TRIALS

'Trumpet' antirrhinum

Ball Holland (now Florensis) recently introduced a new range of antirrhinums with a trumpet-shaped flower rather than the traditional snapdragon shape. In 2009 the CFC was supplied with two trial lines, AHC 129 and AHC 130, which were planted as demonstrations under protection and in outside plots in week 28 using a planting density of 64plants/m^2.

The performance of the plants, both in tunnels and outside, was impressive, with a striking flower form. The reactions of growers, packers and supermarket representatives on visiting the CFC were very encouraging, and, as a result, more varieties of this line will being included in the trials programme for 2010.

Examples of two new varieties of 'trumpet' antirrhinums

Column stocks for autumn-flowering

In 2008 a Dutch propagator had suggested that, if autumn stocks are propagated in large blocks rather than small plugs, they should flower both earlier and more evenly. Starting in blocks would produce a larger, more robust plant that would be expected to establish quickly, hence producing a better quality crop. A trial was therefore set up at the CFC,

planting both plug-plants and plants raised in peat blocks in plots in a tunnel in weeks 26, 28 and 33. Parallel evaluations were also set up on two grower's holdings.

The trial demonstrated there was no advantage to be gained from planting peat blocks, because the crop still flowered very unevenly, and the later plantings did not flower before the tunnel covers needed to be removed for winter. These results were confirmed by the evaluations undertaken on the commercial sites.

Ornamental brassica

Following on from the Centre's earlier work, a small trial was established to compare the production of ornamental brassicas by direct-seeding with traditional plug production. Owing to the extreme dry weather conditions, germination was very erratic and it was not possible to obtain any meaningful results. This trial will be undertaken again in 2010.

Sedum

The sedum stock-plants previously grown at Kirton were re-planted in outside beds on the new trial site. However, they did not flourish and the trial was therefore discontinued.

Discussion

The previous report of the CFC highlighted its opportunity (1) to continue its trials work on those seven crops – annual dianthus, 'German asters', ornamental brassica, delphinium, larkspur, phlox and sedum – already identified as providing definite new opportunities for cut-flower production in the UK, and (2) to continue to seek to identify, demonstrate and trial novel crops presently not known in the UK, or not regarded as suitable for growing here, which nevertheless were seen by the CFC as possessing some real potential. In 2009, of the seven crops noted above, significant progress was made with 'German aster', annual dianthus and phlox trials, while noteworthy demonstrations of three further crops – 'Karma' dahlias, 'trumpet' antirrhinums and column stocks for autumn flowering – were made, that enabled definite decisions to be reached to continue with, or abandon, those subjects. Weather-related and cultural problems in 2009 led to unsatisfactory crop development in the case of ornamental brassicas and sedums, while trials on delphinium and larkspur were deferred until 2010.

Dianthus (annual)

CFC trials in 2008 showed there was a need to improve stem weight in plants cropped from August onwards, and to determine whether high planting rates could be used to increase the yield of stems/m^2 in a crop for which seed is expensive. Regarding stem weight in August pickings, delaying planting to week 30 did reduce stem yields, though stem weight and length remained consistent. 'Neon Purple' and 'Rose Magic' were consistent in the quality of stem produced across the different planting dates and planting densities, but yields were highest when planted at week 28. It would appear from this result that it would not be worthwhile to extend planting beyond week 28 or 29, at least under these conditions. In 2009 it was shown that planting density had no clear effects on yield, length or weight of stems or cropping date, despite the wide range of planting densities tested. These are vigorous plants and it appears the competitive effects of closer planting do not permit a higher yield to be taken, so there was no advantage in using higher planting densities.

'German asters'

These striking new varieties of China asters attracted considerable interest in the CFC trials in 2008, but information was lacking in a number of areas, including about planting densities and planting dates. In 2009 the trials showed that the yield of stems increased as the density

of planting was increased, but as it did so stem weights fell and picking was slightly delayed and stem weight and length fell with later planting.

Other cultural aspects investigated in 2009 included the use of pinching and double-cropping. It was shown that there was little advantage in pinching crops: pinching resulted in stems of lower weight and length and later cropping. Double-cropping produced many more stems, but these were of poor quality and did not meet the required specifications for stem length and strength.

It was found in 2009 that plants of all varieties and planting dates developed symptoms of infection by TSWV and INSV, probably as a result of a chance infestation by WFT. This indicates the need for effective thrips control in future plantings.

The 2009 trials resolved many of the issues previously raised, but other factors still need to be investigated, including height restriction (probably using Alar), achieving earlier cropping, seed provenance (varieties are not uniform, and appear to be coming from more than one source), and the performance of 'Gala' from earlier planting. It is proposed to look at these issues in 2010, including further evaluations on a commercial nursery.

Phlox

From the trials in 2008 on phlox it was clear there are a number of issues to address, including quality, the restricted colour range, limited availability and vase-life. As the stock plants were transplanted from Kirton to Rookery Farm in 2009, it was only practical to continue the varietal comparison, but vase-life was specifically investigated. Tests showed that there was considerable variation in vase-life, but, in contrast to previous impressions, the vase-life could be very acceptable. Thus, of the cultivars trialled, 'Sugar Missy' not only produced the greatest yield of stems with the greatest length, but also had the longest vase-life of those tested, from 18 to 21 days. In five other varieties vase-life varied between 12 and 19 days, and in one, 'Ice Cap', it fell well below the minimum of 11 days needed. Further cultivar comparisons may be worthwhile.

'Karma' dahlia

This new line of dahlias has evidently been produced to give dahlias with improved vase-life. In 2009 the CFC demonstration of 'Karma' dahlia cultivars elicited a very encouraging response from many who visited the trials site – they created great visual impact and stems

were strong and colourful, though those grown in the tunnel were by far superior. Six of the 18 varieties grown were affected by powdery mildew, but this should not be difficult to treat now that the susceptibility is known.

Except for one of the 18 varieties they produced high, if variable, numbers of marketable stems within a reasonable period, with average picking dates mostly between week 36 and 38, following planting in weeks 24 or 26. Average stem length was reasonably consistent across the 18 varieties, around 40 to 50cm. However, stem yield and weight were variable, so careful varietal selection for these factors would be required.

Six of the 18 cultivars grown were severely affected by powdery mildew. In future this should be controllable, given the knowledge of susceptibility. The intense colonisation of the stems of two varieties by wasps was an unexpected occurrence and evidently an unusual one. It has been known for many years that wasps will gnaw at the base of dahlia stems[1] – no other plants are listed - though this fact does not appear to have made its way into horticultural textbooks.

Despite their other excellent qualities, vase-life was disappointing. The total shelf/vase-life achieved never approached the total of 11 days deemed necessary for commercial acceptance, and, unless this can be rectified, it is difficult to see how 'Karma' dahlias could be taken forward as a commercial cut-flower. However, a literature review (see Appendix) indicated that there may be scope for other flower treatments to be tested.

'Trumpet' antirrhinums

Two lines of a new range of antirrhinums with a trumpet-shaped flower were demonstrated at the CFC in 2009. Their performance and appeal were impressive, and the reactions of the industry were very encouraging and trials will be extended in 2010.

Column stocks for autumn-flowering

It was suggested that column stocks propagated in large blocks rather than small plugs should flower earlier and more evenly, since starting in blocks would produce a larger, more robust plant that would establish quickly. However, in a trial and commercial evaluations in 2009 it was found that there was no advantage to be gained from planting peat blocks,

[1] ADAS (1978). *Wasps.* Leaflet GD 53 (revised 1978). MAFF (Publications), Pinner, UK.

because the crop still flowered very unevenly, and the later plantings did not flower before the tunnel covers needed to be removed for winter.

Ornamental brassica

Following on from the Centre's earlier trials, a small trial was established in 2009 to compare the production of ornamental brassicas by direct-seeding with traditional plug production. Unfortunately, owing to the extreme dry weather conditions, germination was very erratic, and this will be undertaken again in 2010.

Sedum

Sedum stock-plants previously grown at Kirton were re-planted in outside beds on the new trial site but did not flourish. Sedum trials or demonstrations are being reconsidered.

Other crops

Pending further discussions, no further trialling was carried out on larkspur and delphiniums in 2009, and this is being considered for the 2010 programme.

Technology transfer

Articles relating to the Centre have been included in *HDC News* and *Horticulture Week*, there was a well attended Open Day at Rookery Farm on 15 September 2009, and the site has been visited by growers, propagators, marketers and supermarkets throughout the year.

The future

Funding by the HDC of the CFC for 2010 to 2012 is now in place, and the Centre's detailed plans for its 2010 programme are being drawn up. **Growers who would like to know about other novel cut-flowers are encouraged to contact the project leader or the HDC with suggestions for the Centre's programme in 2010 and beyond.**

Acknowledgments

Thanks are due to many people and the Project Leader apologises to anyone who may have been missed. Special thanks go to all members of the Management Group and to Rookery Farm for the time they have dedicated to the project: David and Elaine Robinson (Rookery Farm), Sue Lamb (Lambs Flowers), Simon Crawford (Flowers by Design), Jo Pearson (Fast Track Flowers), Phil Collison (J Collison & Son), Gordon Flint (Winchester Growers), Louise Motala and Sue Steptoe (Waitrose), Jane Stanbury (ASDA), Roy Willingham (formerly HDC BOF Panel Chairman), Hugh Frost (HDC), Ruth Ashfield (HDC) and Gordon Hanks (HDC Project Co-ordinator).

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APPENDIX

A brief review of research on the vase-life of dahlia

Gordon Hanks

Introduction

During 2009 plots of 'Karma' dahlia cultivars were grown in outside beds and in Spanish tunnels as part of the HDC-funded trials programme of the Cut-flower Trials Centre based at Rookery Farm, Holbeach St John, Lincolnshire. The large, bright flowers in an impressive range of colours attracted the attention of growers and packers, but vase life tests carried out for the Centre gave disappointing results. The flowers failed to reach the minimum of 11 days post-harvest life required for the period between picking to end of vase-life. But, according to the Verwer Dahlia BV web-site[2] the Karma Dahlia Collection…

> "…is a line of dahlias carefully bred and selected to produce dahlias especially suited for cutting… dahlias have long been favourites as cut flowers. And there are very few other ornamental plants that produce such a wide variety of flowers in such bright colours. As a cut flower, the dahlia's weakest point has been its limited keeping quality. For this reason, the varieties in the Karma series have been selected for their keeping quality as well as their floriferousness, floral shape and colour, and long, straight, sturdy stems with little or no lateral branching. Karma dahlias can be cut at a fairly immature stage and have a vase life ranging from 7 to 12 days."

A literature search was therefore carried out to discover if there might be some clues as to how dahlia vase-life might be prolonged to an acceptable commercial duration. The search, conducted in November 2009,[3] revealed there had been only patchy investigations into the vase-life of dahlia and how it might be extended. The research came from several countries - including India, Poland, the Netherlands and the USA – in some of which the cultural and environmental factors would restrict the usefulness of the findings as far as UK growers were concerned.

Research review

Dahlia cut-flowers are large and attractive but are normally picked in full bloom and thus easily damaged at cropping or during transport. Their vase-life was investigated by

[2]http://www.verwer-dahlias.nl/en/karma_intro_en.htm
[3]CABI Horticultural Abstracts, 1976 to 2009 week 45

Lukaszewska (1980, 1983) at Skierniewice, Poland, who wrote that, because of these problems, dahlia "remain a seasonal and practically amateurish crop of only marginal significance for the flower market in Poland".

In the earlier study (Lukaszewska, 1980) several cultivars were cut with "semi-open buds" and various vase additives were tested for their effect on vase-life and flower quality. The main findings are listed here.

- Neither silver nitrate (50ppm), 8-HQS (200ppm) nor the germicides NaN_3 (10 or 50ppm) or $Al_2(SO_4)_3$ (50 or 200ppm) affected vase-life.
- The addition of sugar (5% glucose, fructose or sucrose) reduced vase-life, compared with using plain water or water with 8-HQS.
- In 'Purple Gem', increasing the pH of the vase solution from 2.2 to 8.9 decreased the vase-life from 6 days to 1 day.
- Adding sugar, however, did increase the opening of flowers and improved their size and shape in the vase, especially using the higher concentrations of glucose.

In the later study (Lukaszewska, 1983) 'Purple Gem' dahlias were picked "semi-open" (when the ray-florets in the three or four outer whorls had unfolded). They were placed in flower food for 24 hours and then moved to plain water, or were kept in the water containing the flower foods. The main findings were as follows.

- At concentrations of 5 or 10%, glucose was more effective than sucrose in extending vase-life but the two sugars had similar effects on flower opening.
- Silver nitrate was most effective in extending vase-life when applied alone or in combination with 8-HQS; silver chelated with EDTA did not extend vase-life and flower appearance was damaged, and STS also degraded flower appearance.
- A 24-hour pulse with glucose (10%) plus silver nitrate or 8-HQS or both was as effective in enhancing vase-life and flower size as a continuous treatment.
- Vase-life was longest (9 days, compared to the control's 4 days) when a solution of 10% glucose and 0.2mM silver nitrate had been used; adding 8-HQS (200mg/L) to the glucose and silver nitrate produced a similar result (an 8-day vase-life).

Experiments on dahlia vase-life were also carried out by Swart at Lisse in the 1980s (Swart 1986, 1989). In the earlier of these studies, 'Eveline' stems were harvested at "full bloom" or "tight bud" stages, with the following findings:

- When harvested at the tight bud stage, full bud opening could still be achieved;
- Placing stems in "carnation Chrysal" (13g/L) during storage and in the vase extended vase-life compared with using plain water, but only by about 1 day;

- Storage at 2°C (for 24 or 48 hours, compared with 9°C) was not harmful and even prolonged vase-life, though the longest vase-life recorded was only 9 days (with petals starting to drop on day 4);
- Vase-life varied from year-to-year and from cultivar-to-cultivar, and it was suggested that a breeding programme to improve post-harvest quality would be worthwhile;
- "Commercially available carnation-bud forcing mixture (27g/L)" was more effective than "carnation Chrysal".

In the later study, Swart (1989) confirmed that dahlias could be picked at the relatively immature stage, provided the stems were placed immediately in water with flower food, either:

- 'Chrysal AKC' (24g/L) or
- 'Anjer- [carnation] Chrysal' (13g/L).

Despite these encouraging results, the overall impression of dahlia vase-life appears to have been summarised by the author in the title of the 1989 paper: "Short vase life [in dahlia] remains a selling problem". The usefulness of 'Anjer-Chrysal' (compared with 'Tulpen-Chrysal') had been reported a decade earlier by Staden (1976): it "gave a vase-life of at least one week" [!].

At the Sprenger Institute in Wageningen, Woltering (1984) had previously tested the response of several cut-flowers, including dahlia, to ethylene. Flowers were exposed to 3ppm ethylene for about 23 hours at 20°C, either with or without a prior treatment with silver thiosulphate (STS) (at 6°C for about 20 hours). Dahlias showed only slight damage as a result of exposure to ethylene and no response to STS. Confirming this, Dole *et al*. (2009), working at North Carolina State University (NCSU), also found that cut dahlia were unaffected by exposure to ethylene (10µL/L for 16 hours, with or without a prior pulse with 'anti-ethylene' compounds[4]).

Dole *et al.* (2009) further reported the vase-life of a selection of cut-flowers, including field-grown 'Karma Thalia' dahlia. Their main findings were:

- Cut dahlias can be held in plain tap-water or deionised water (either plain, with 8-HQC (200mg/L), with acidification to pH 3.5, or with 8-HQC and acidification) with no difference in subsequent vase-life (thereafter plain deionised water was used as the control);

[4]Either STS (as 'Chrysal AVB' at 1mL/L) or 1-methylcyclopropene (giving a final concentration of 700nL/L)

- Placing the stems in vases, with or without pre-soaked 'Floral Foam' [florists' foam or 'Oasis'], with 2 or 4% sucrose had no effect on vase-life compared with plain water;
- Giving a 24-hour pulse in 10 or 20% sucrose at 20°C, before returning to plain water, also had no effect on dahlia vase-life;
- Using 'Floralife Professional' or 'Chrysal Professional 2 Processing Solution' (both at 10ml/L) improved vase-life slightly, from 8.6 days on plain water to 10.8 and 10.1 days, respectively; and
- Dry or wet storage at 2°C (at 80-90% humidity) for 1 week reduced vase-life to about 6.5 days, compared with non-stored stems (8.5 days).

In a popular account, presumably reporting the above research at NCSU, Fanelli & Dole (2006)[5] reported results with 'Karma Thalia' and 'Karma Naomi' dahlias. "The longest vase life was obtained when flower buds were cut at the breaking stage (one petal open) and 50 percent color. The buds required 3.1 to 4.5 days to fully open and lasted a total of 12.1 to 12.8 days if placed in 2 or 4 percent sucrose or commercial holding solutions ['Chrysal Professional 1 Processing Solution']. Fully opened 'Thalia' flowers attained full size and color with this treatment, but many 'Naomi' stems cut at flower bud stage did not fully open or develop true color whether the stems were held in water (control), sucrose or commercial holding solutions."

Many papers on cut-flower crops are being published in national sources reporting research in India, an indicator of this country's developing ornamentals industry. Dahlia has been the subject of a number of studies. For example, Dhane & Nimbalkar (2002) studied the growth and flower performance of 25 dahlia cultivars with a view to aiding selection by growers and highlighting any needs for plant breeding. Vase-life (in plain water) ranged between 2 days for 'Shooting Star' and 8 days for 'Cheroky Beauty'. Balas *et al.* (2005) studied the production of dahlia cut-flowers in various growing systems; the abstract of this paper mentions that vase-life was studied but gives no further details (a copy of the paper is on order).

There are also short reports of relevant work in the Annual Reports of Lisse (1976, 1983), of the Sprenger Institute (1977, 1978) and of Aalsmeer Research Station (1975), which are yet to be consulted.

Textbooks

[5]http://www.greenhousegrower.com/magazine/?storyid=498

Information on dahlias is included in a number of textbooks on flower production. For example, Armitage & Laushman (2003) included the following information.

- "[Dahlia] flowers do not ship particularly well, making dahlias a good [?] product for the local market".
- They should be picked when "75% to fully open", before the outer petals begin to decline; if cut too early, the flowers fail to open, even in an opening solution.
- After harvesting, some growers immerse the stems in warm water (54°C) which is then allowed to cool (see also Nowak & Rudnicki, 1990).
- The flowers should be cropped in the morning, and should be placed immediately in hydrating solution.
- Storage should be avoided if possible, but if unavoidable, they can be stored wet at 3 to 4°C and 80% humidity.
- Dahlias should always be shipped in water or preservative.
- Vase-life is 3 to 4 days, or 7 to 10 days if an opening solution is used (see also Nowak & Rudnicki, 1990, and Vaughan, 1988).

The Ball Publishing text "Cut flowers: Prolonging freshness: Postproduction care and handling" still needs to be consulted (The British Library's copy has "disappeared").

Conclusions

What research has been published on the subject seems to have been sporadic and incomplete. While there were indications that some 'flower foods' could produce an increase in vase-life, the improvement was small, up to 2 days, and the longest vase-life reported approached 12 days - and was often much less. It does appear that picking blooms at a relatively early stage can be achieved. A number of discrepancies between studies were also evident, for example, as to whether treatments containing sugars, or cold storage, were useful, though these may have been due to the use of disparate cultivars (between-cultivar differences are large) and different cultural and experimental techniques.

By optimising the picking stage, using varietal choice, ensuring the rapid transfer of stems to water containing suitable additives, and holding stems at 2°C, it would be interesting to see whether the reports of vase-lives of up to 12 days could be replicated.

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