Alstroemerias (*Alstroemeria* hybrids) as a tunnel-grown cut flower crop

Grower summary

- Building on successful hybridisation since the 1980s, alstroemerias have become rapidly established as one of the major cut flower crops worldwide. In Western Europe and North and South America, they are mostly grown under glass as all-year-round (AYR) crops. In the UK, the glasshouse-grown alstroemeria crop has declined rapidly in recent years and large quantities are now imported from the Netherlands
- Hybridisation has produced blooms of a wide colour range with attractive flower forms and good vase life (VL). Modern cultivars are almost all subject to Plant Breeders' Rights (PBR) and raised via micropropagation, making the planting material relatively expensive. As a result of the popularity of polythene tunnels in UK cut flower production, a trial was designed to examine older and garden cultivars, no longer subject to PBR, which might form the basis of a less expensive, summer-grown crop produced in tunnels
- Twelve commercial cut flower and standard garden cultivars, none protected by PBR, were grown in beds, either in a tunnel or outdoors, for three years. Tunnel-grown plants established and overwintered well, producing good yields of long, marketable stems of surprisingly good quality with a VL of around 12 days
- Equivalent plots in outdoor beds gave lower yields, but their quality was still acceptable and such crops might work well for some smaller cut flower businesses
- With a combination of 12 cultivars grown under polythene and outdoors, flower picking extended over a five-month period (up to the onset of winter weather) with a few short gaps in supply
- Stem yields increased or were maintained over the three years of the trial. These results confirmed the concept of growing a summer crop of alstroemeria under relatively low-tech conditions
- Alstroemeria cultivars outside of PBR could be propagated from the vigorous, rhizome-like tubers after a flower production cycle to form a stock for growing-on

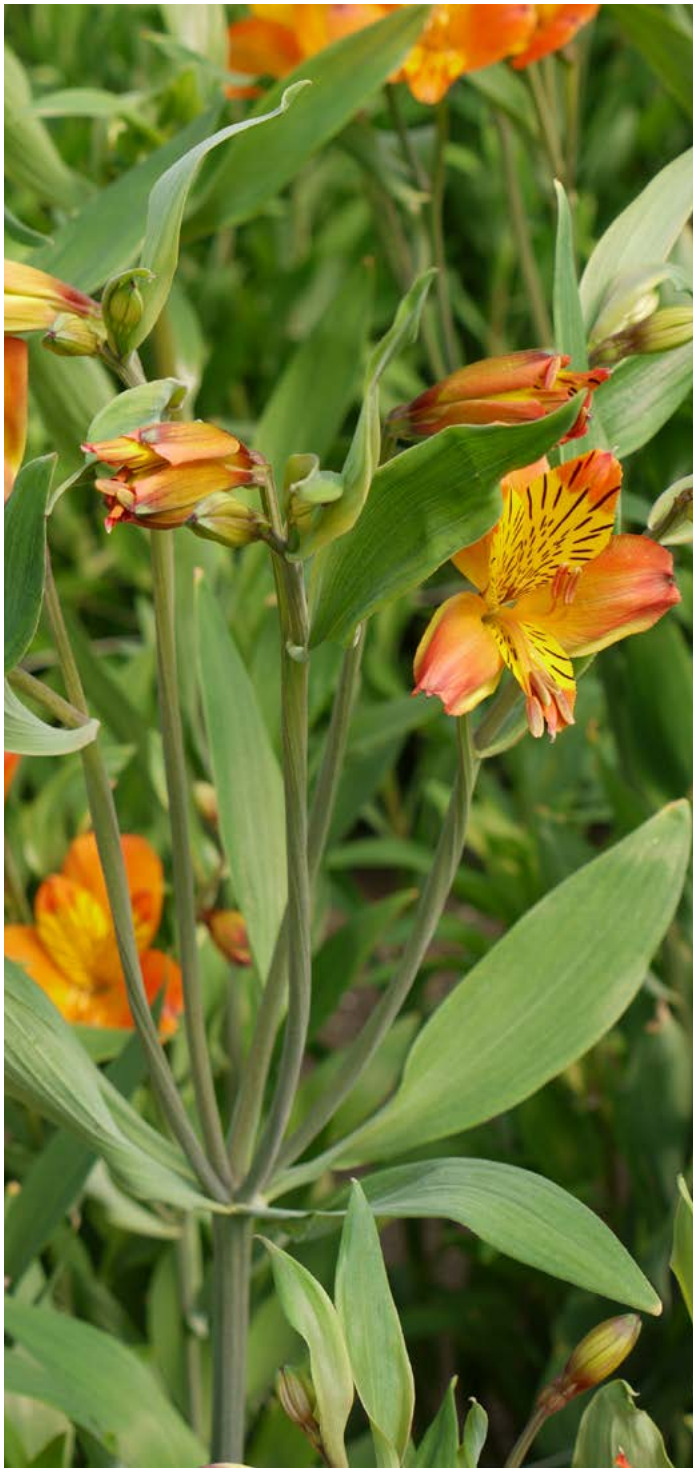

Figure 1. The intensity of flower colour of cut flower alstroemeria cultivars

Introduction

The South American genus *Alstroemeria* is a relatively new addition to floriculture, having quickly gained popularity to become one of the major cut flowers worldwide. Alstroemerias (Peruvian or Inca lily) are prolific when grown under cool conditions and have attractive flowers in a range of colours with a good vase life (VL), so it is not surprising they have become very popular. Most are grown in glasshouses in Northern Europe (including the Netherlands and the UK), the Northern USA and South America (mainly Columbia). They are generally all-year-round (AYR) crops though peaking in production during spring and early summer. Some are grown in the field in coastal California, peaking in the autumn and early spring.

Since the 1980s, the breeding of improved alstroemeria cultivars has intensified, resulting in a highly competitive market and the widespread use of Plant Breeders' Rights (PBR) also known as Plant Variety Rights. Alstroemerias are usually grown as a glasshouse cut flower, using micropropagation-derived planting material of protected cultivars subject to royalty payments, so plant costs are relatively high.

Alstroemerias were only recently included in the Cut Flower Centre (CFC) trials, when the increasing availability of Spanish and related types of polythene tunnels provided potential for the production of an inexpensive, seasonal tunnel crop using older or garden cultivars with no (or expired) PBR. A four-year evaluation trial was set up in 2014.

Modern alstroemerias produce loose, compound, terminal umbels of florets in often subtle shades including white to dark yellow and varied pinks, purples, violets and reds; characteristically (except for some Japanese hybrids in which these characters have been bred out) the throat of the flower is yellow and the base of the petals is ornamented with black spots. Alstroemerias are also produced as herbaceous plants for the garden and landscape, while dwarf and semi-dwarf hybrids are container-grown as patio plants or flowering pot plants. Alstroemerias in general are hardy down to -10°C, though hybrids of *Alstroemeria aurea* and *A. ligtu* tolerate brief periods down to -15°C and so fall between being frost hardy and fully hardy.

An important theme in alstroemeria production is the considerable between-cultivar variation in response to temperature, light, etc, but this is not surprising considering the range of species used in the hybridisation process and the diversity of their natural habitats and life cycles. Of the 50 or so *Alstroemeria* species, modern hybrids have been derived mainly from *A. aurea* (syn. *A. aurantica*), *A. ligtu, A. pelegrina* (syn. *A. gayana*), *A. pulchra* and *A. violacea* (syn. *A. paupercula*). Their habitats vary from dry, warm, desert-like regions to moist, cool, high altitude sites. Crossing Chilean species (winter growing) and Brazilian species (summer growing) resulted in hybrids that were more or less evergreen and flower for most of the year.

Frequent contact with alstroemeria foliage and flowers has reportedly caused dermatitis in some individuals, so appropriate protective wear (eg gloves and long sleeves) should be considered. Under some conditions, alstroemerias can become invasive.

Cultural requirements and production methods

CFC trials could not cover all aspects of production, so the information in this section was compiled from textbooks, research findings, web-based information and the catalogues and websites of seed and young plant suppliers, augmented where possible by the results of CFC trials.

The information below is an attempt to provide a consensus of the key aspects of commercial alstroemeria production, and is given for guidance only. As alstroemerias are primarily grown in glasshouses, much of the cultural information is derived from glasshouse-grown crops, but it may nevertheless provide guidance for other production systems.

Cultivars

Starting in the 1980s, several groups have made significant advances in hybridising alstroemerias, resulting in many new hybrids and considerable advances in flower colour and form, with AYR flowering as opposed to production in distinct flushes. New commercial hybrids are usually protected by PBR, adding to plant costs through royalty payments and the prohibition of vegetative propagation from flowering stock; limiting their availability to the relatively high-end markets. However, PBR expire after 25 years, permitting the use of older, non-PBR hybrids as short-term seasonal, summer crops in unheated polythene tunnels.

Companies currently involved in breeding, selecting, propagating and supplying PBR-protected alstroemerias to growers include HilverdaKooij (working with Domenico Gagliardi and HortiPartners) (**http://www.hilverdakooij.com/en/cut-flowers**), Könst Alstroemeria (**http://www.alstroemeria.com**), van Zanten (**https://www.royalvanzanten.com/en/products**) and Wulfinghoff (**https://www.wulfinghoff.nl**). HilverdaKooij also supplies 'Florinca', a new range of spray alstroemerias. Many other companies, such as Ball Colegrave and PanAmerican Seeds, market seeds of garden and compact cultivars only.

Relatively few companies, however, are wholesale suppliers of cultivars without PBR or with PBR that have expired; Parigo Horticultural (**http://www.parigo.co.uk/products.html**) is a notable exception. The non-protected cut flower cultivars currently available on Parigo's website and the associated Alstroemeria Direct (**http://www.alstroemeria.co.uk/index.php/products-mainmenu-64/standard-height**) are included in the list of candidate cultivars for trialling as a polythene tunnel crop (Table 1). Large numbers of other cultivars have either never been the subject of PBR, or have PBR that have now expired either after the 25-year period or for other reasons (eg withdrawal from the scheme). Table 1 also includes a selection of recommended cultivars that were considered worthy of mention in horticulture textbooks from about 25 years ago. Cultivars were listed only if they were absent, or had their registration shown as expired or otherwise withdrawn before 18 May 2017, from UK and EU registrations of PBR on the Community Plant Variety Office (CPVO) database **https://cpvoextranet.cvpo.europa.eu**

Table 1. Some candidate non-protected alstroemeria cultivars for cut flower evaluation in tunnels (cultivars in bold were included in the CFC trials)

Cultivar	Flower colour	Original use and source
'Aimi'	Yellow	Garden use[1]
'Amarillo'	Soft peach	Glasshouse/outdoor[1]
'Apollo'	White	Garden use[1]
'Aruba'	Salmon pink	Glasshouse[3]
'Avanti'	White	Glasshouse/garden use[1]
'Blushing Bride'	Pale and darker pink	Garden use[1]
'Bolera'	Dark red	Garden use[1]
'Bonanza'	Dark pink	Garden use[1]
'Candy'	Deep pink	Glasshouse/outdoor[1]
'Capri'	White with pink markings	Glasshouse[3]
'Carousel'	Cream	Glasshouse/outdoor[1]
'Cavalier'	Pink	Glasshouse[3]
'Charm'	Maize yellow	Garden use[1]
'Cinderella'	Pink	Glasshouse/outdoor[2]
'Dana'	Soft pink	Glasshouse/outdoor[1]
'Eleanor'	Yellow	Glasshouse/garden use[1]
'Elvira'	Pale pink with bold stripes	Garden use[1]
'Flamengo'	Pink	Glasshouse[3]
'Flaming Star'	Bright orange	Garden use[1]
'Friendship'	Cream/very pale yellow	Garden use[1]
'Golden Delight'	Golden yellow	Garden use[1]
'Java'	Salmon pink	Glasshouse[3]
'Jubilee'	Purple/lilac	Glasshouse/outdoor[2 3]
'Laguna'	Bright mauve	Glasshouse/garden use[1]
'Lorena'	Pink	Glasshouse/outdoor[2]
'Marina'	Red	Glasshouse[3]
'Nina'	Cream	Glasshouse/outdoor[1]
'Orange Flame'	Bright orange	Glasshouse/outdoor[1]
'Orange Glory'	Dark orange	Garden use[1]
'Orange Supreme'	Orange	Garden use[1]
'Petronella'	White with pink markings	Glasshouse[3]
'Pink Sensation'	Lilac pink	Garden use[1]
'Pink Triumph'	Pink	Glasshouse[3]
'Polka'	Deep pink and blotch	Garden use[1]
'Rebecca'	Rose and white	Glasshouse/outdoor[2 3]
'Rosario'	Rose and white	Glasshouse[3]
'Selina'	Pale pink with blush	Garden use[1]
'Serenade'	Cream with pink centre	Garden use[1]
'Tanya'	Red	Glasshouse/outdoor[1]
'Tiara'	Red	Glasshouse[3]
'Ventura'	Orange/peach	Glasshouse/garden use[1]
'Victoria'	Orange/salmon	Glasshouse/outdoor[2 3]
'Yellow Dream'	Yellow	Glasshouse/outdoor[2]
'Yellow King'	Yellow	Glasshouse[3]

[1] Parigo (2017)

[2] Armitage and Laushman (2003)

[3] Grower Books (1994)

The following are some additional sources of information about alstroemeria cultivars. It is not always easy to identify non-PBR cultivars and careful research is needed to identify those that are suitable.

Note that a cultivar may be referred to by the name given it by the raiser, or by the name under which it is later traded (eg 'Konxanadu'/'Xanadu' from Könst, or 'Tessadele'/'Adele' from HilverdaKooij), but not all listings carry both alternatives.

- The Community Plant Variety Office (CPVO) maintains a list of cultivars with their current PBR status: **https://cpvoextranet.cvpo.europa.eu**. Sign in to access the list
- The Koninklijke Algemeene Vereeniging voor Bloembollencultuur (KAVB) is the International Cultivar Registration Authority for alstroemerias: search for alstroemeria on **http://www.nccpg.com/National-Collections/Collection-Results.aspx?id=1021** Very few non-protected cultivars are now registered, so its content is similar to that of the CPVO lists
- The Royal Horticultural Society (RHS) Horticultural Database includes over 1,000 alstroemeria names: search for alstroemeria at **http://apps.rhs.org.uk/horticulturaldatabase**
- Viv Marsh Postal Plants has a list of over 100 cultivars for garden use: **http://www.postalplants.co.uk/default.asp** and also hosts a National Collection (with a mirror collection at Pershore College): **http://www.nccpg.com/National-Collections/Collection-Results.aspx?id=1021**

Scheduling and production systems

An understanding of the alstroemeria life cycle helps to explain the production process. Until the shoots emerge, all active growth is subterranean. The branching, rhizome-like tubers bear aerial shoots, and further aerial shoots and tuber growth appear from axillary buds at their base.

The terminal growing point of the rhizome always grows downwards by a few degrees which means that, after a few years, they may form a clump that is growing into a layer of soil that is infertile or poorly drained, hence the usual production system involves replanting the rhizomes every two to four years.

Under glass, young plants are often planted in the summer, up to late-September, after the main production period has ended. Picking then peaks in March to June, sometimes with another flush a few months later, say September to November; some older cultivars may fail to produce a second flush. Some, and especially newer, cultivars can be planted in most months, say from February to September (excluding August). They may still exhibit flushing, but flowers are produced almost AYR (and, crucially, with better winter flower production) provided that soil temperatures do not become excessive.

In general, weaker cultivars should be planted relatively early (to allow root establishment before temperatures and light levels fall towards winter) while the more vigorous ones can be planted relatively late (early planting will lead to excessively fast establishment and the production of too many weak or vegetative shoots). Some vigorous, older cultivars grow excessively tall after the first year so may need replacing after a single year.

One system for growing alstroemerias in the field is to pot up plants obtained in the autumn and hold them under glass until April, when they are planted in the field.

Flowering will begin in June, but these early flowers will be pulled and peak picking will be in August. In warmer climates, planting in the field can take place in August, with picking starting in October and peaking in March and April.

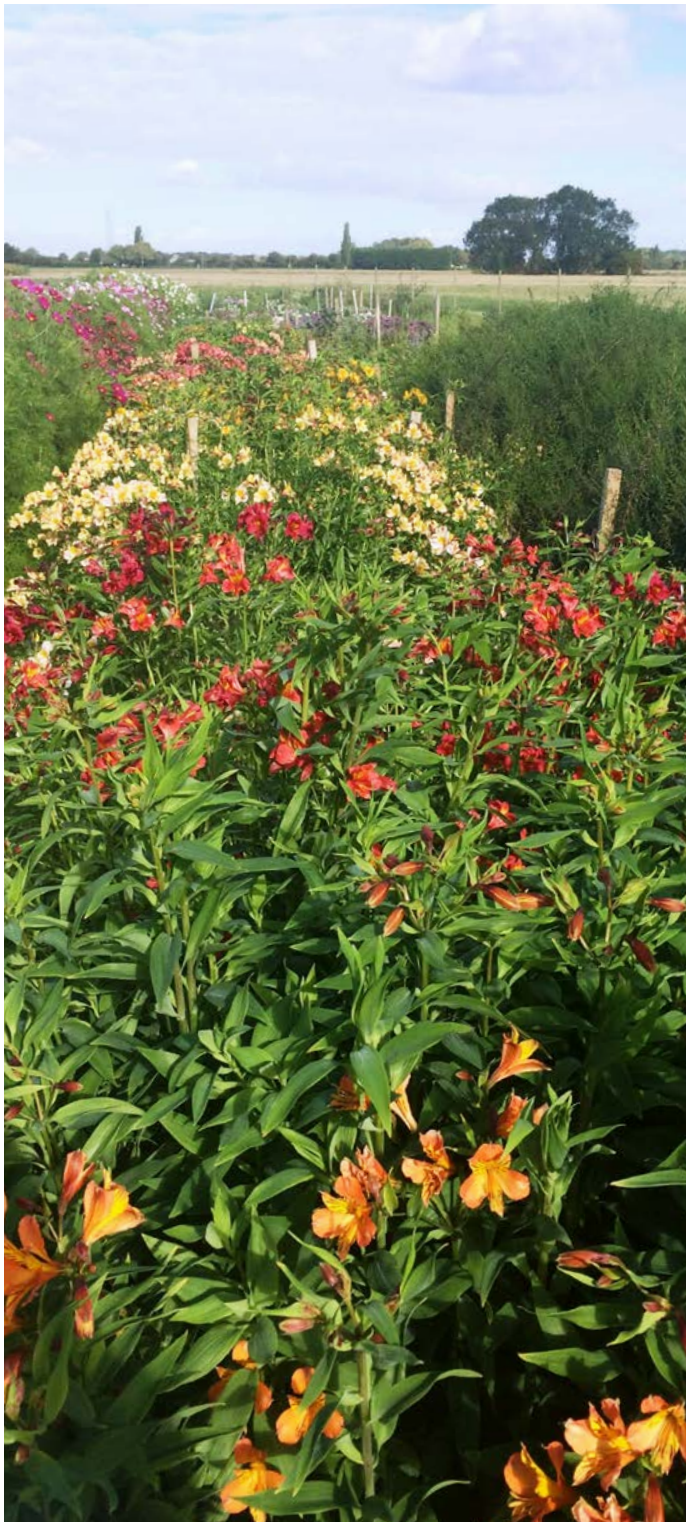

Figure 2. Field-grown alstroemerias

Propagation

Micropropagation is routine for new and other hybrids, adding to production costs. Plants are often supplied, in cells or small pots, as tubers with three or more vegetative shoots. Subject to the restrictions of PBR, rhizomes can be multiplied by division; many cultivars grow vigorously, which should allow the rapid increase of stock where appropriate.

Alstroemerias are not usually raised from seeds, although this is straightforward: after sowing, the trays can be cooled for 2–4 weeks at 7–10°C, with germination rates of 50–70 per cent quoted.

Planting

Young plants should be irrigated before planting and then watered-in afterwards. Rhizomes with shoots should be transplanted promptly, not planting deeper than they were in the previous container (another source suggests planting the rhizomes 8–10cm deep). The growing points should be positioned towards the centre of the bed, and the roots should be handled and spread out with care because they are an important store of starch for the growing plant.

For field-grown alstroemeria, one recommendation suggests spacing either at 30–45cm centres or at 45×50cm. Two rows planted on a 90cm-wide bed are more productive than a single 60cm-wide row. Other recommendations suggest planting at between 12.5 and 60cm centres or (under protection) at 40×50cm or 50×60cm or at 3–3.5 plants/m^2. With experience, planting density will depend on the vigour of the hybrid and the length of time they will be left down. Under protection, the soil should (if practical) be kept cool (optimally at 13°C) for a minimum of six weeks after planting.

Growing conditions

The soil for alstroemeria production should be open in structure and well drained. High salt levels should be reduced by leaching prior to planting. A pH between 6.0 and 6.5 has been suggested, but crops appear to grow well in soils outside this range.

The soil should be cultivated to a depth of at least 30–50cm (recommendations vary). In glasshouse beds, the soil can be amended with peat, perlite, sand, calcined clay or various organic or inorganic amendments. Farmyard manure has been favoured, but must be well rotted and properly incorporated. Unless soil analysis indicates specific deficiencies, a base dressing of a general compound fertiliser can be made at 2.2t/ha. It is possible to grow alstroemeria in either peat or perlite.

Flower initiation is controlled by the temperature of the rhizome, so soil temperature is critical in alstroemeria production. The optimum treatment for vernalisation is six weeks at 5°C, though flower initiation still occurs, slowly, at 13°C. If soil temperature remains below 15–16°C, alstroemeria will flower for an extended period, irrespective of air temperature. Flowering shoots can be produced over the range of 9–17°C. Flowering from induced rhizomes is reduced when grown at over 17°C, and rhizomes are de-vernalised at or above 21°C and then only vegetative shoots are produced.

Figure 3. Planting alstroemerias at the start of the trial at the CFC

These responses apply only to planted, watered rhizomes; dry-stored rhizomes do not respond to temperatures. In practical terms, temperatures of 10–13°C at night and 16–18°C during the day result in continuous flowering.

One recommendation is to maintain minimum night temperatures of 16°C (for early plantings) or 14°C (for later planted, more vigorous cultivars) until establishment, when temperatures can be reduced as light levels fall (in Northwest Europe to 10–12°C and possibly then 8°C) and raised again in spring (to not more than 20°C), repeating this sequence in subsequent years. Maximising light intensity is important to ensure flower quality so, under glass, the use of shading is minimal and only used when attempting to reduce soil temperatures or to prevent sun scorch in the case of some older, sensitive cultivars.

Providing the rhizomes have been vernalised, supplementary or night-break lighting can be used under glass to produce 14–16-hour days to induce earlier flowering. Exposure to short days (eight hours) delays flowering. Carbon dioxide enrichment is also reported to increase yields to varying extents.

Nutrition and irrigation

One fertiliser recommendation is for a weekly application of nutrients, based on supplying 200–280ppm nitrogen, supplied as calcium nitrate and potassium nitrate, aiming for a soil EC of 1.3dS/m or lower (other reports say there is little effect of EC between 1.1 and 2.1). The application of nitrate nitrogen should result in the required dark-green foliage; ammonium nitrogen should be avoided or reduced, especially in winter. An N:K ratio of 1:1 to 1:4 and a pH of 5.5 were suggested. A high nitrogen feed can be used up to the end of the first flush, switching to a high potassium feed. Regular low-strength feeds have been preferred to less frequent high-strength feeds. The concentration of leaf nitrogen should be about five per cent; guide tissue concentrations of other nutrients have been published. Iron deficiency can result in the loss of vigour and chlorotic new growth, especially on more vigorous cultivars, and should be treated using chelated iron.

Alstroemerias can be watered generously when in active growth, especially in the first flush. However, it is often recommended to grow the crop slightly dry, as soil that is too wet can lead to root rot, especially after the first planting before shoot emergence. *Botrytis* is liable to develop in the dense lower foliage so, as far as practical, overhead irrigation should be avoided and relative humidity maintained at 80–85 per cent.

Plant manipulation and support

Depending upon the cultivar, two to five levels of support mesh have been recommended and should be raised with the crop (and lowered after a flush has finished), the lowest mesh being about 30cm from the ground. Height control is not required.

Pinching and disbudding, as such, are not needed, but shoot thinning is important to maintain good light and air circulation through the crop. Many of the shoots emerging after planting will be vegetative and should be removed monthly or as required, which will stimulate elongation of the axillary buds and maintain flower production. New, weak or pale stems, and any older stems without unfolding leaves, should also be removed. No more than 30 per cent of the stems should be removed at any one thinning. Shoot thinning is carried out by gently pulling the shoot free from the rhizome (there is a natural abscission layer), not by cutting (exceptions are young plants just starting to produce shoots, and many ‘butterfly’ types, which must be cut as they are not strong enough to withstand pulling). Thinning is probably the most costly element in alstroemeria cut flower production.

Depending on the cultivar, there may be cycles of very tall, thin shoots alternating with shoots that are too short. The very tall shoots should be cut to marketable length and the remainder of the shoot left intact for photosynthesis, which helps to prevent the next cycle of short shoots. With short shoots, the flower heads should be sacrificed, again leaving the rest of the shoot for photosynthesis. These stems should be removed once leaf senescence has started or at the next thinning.

Pest and diseases control

Plant protection product treatments are likely to be needed during the production phase, however good ventilation and spacing are important to keep diseases in check. The main pests reported are slugs (if the lower canopy is not kept clean and open) and western flower thrips, the latter being a serious threat to plant quality directly (causing leaf flecking) and as a vector for tomato spotted wilt virus (TSWV). Whitefly, aphid, two-spotted spider mite and (tortrix) caterpillars can also be problematic, and infestations by the nematode *Pratylenchus bolivianus* have been reported.

Routine treatments against water- and soil-borne diseases (such as *Pythium* and *Rhizoctonia*) are required, although soil sterilisation can only be carried out prior to planting/replanting. *Botrytis* can be a problem if there is a thick canopy that restricts air movement and new shoots may rot as they emerge. Both alstroemeria mosaic virus (AlsMV) and TSWV can cause serious problems and potyviruses and phytoplasma infections have been reported. Virus-affected plants should be destroyed promptly.

Figure 4. Net supports on plants in the CFC trials

Picking, specifications and packing

Alstroemeria may show poor subsequent flower development and colour if picked too early; the preferred stage has been given as one to three open florets, or one fully coloured, or flowers showing colour and about to open.

For shipping longer distances however, earlier picking may be unavoidable, typically when the first floret is well coloured and most of the rest are showing some colour, or when the first buds are swollen and about to open.

As mentioned previously for shoot thinning, the stems can be cut or snapped, but snapping should be avoided if there is any tendency to damage the plants below soil level.

As soon as practical, the stems should be stood in deep water, preferably containing a conditioning solution and in the light.

Cut stem length can vary from 80–120cm. Examples of yields quoted include 50–100 stems/plant/year for field-grown crops, and 150–300 stems/m^2/year for PBR cultivars grown under glass.

Post-harvest care

The long VL (two weeks) is one of the main attractions of alstroemerias as a cut flower product and should be safeguarded. Alstroemerias are sensitive to ethylene. The fresh-cut flowers will continue to open for 10–14 days, but the foliage may yellow sooner.

When registered in the UK, the use of silver thiosulphate (STS) and other preservatives will extend VL and reduce leaf yellowing, while STS or 1-MCP (another ethylene blocker available in the UK as Ethybloc) will delay petal drop.

The onset of leaf yellowing can also be delayed by applications of gibberellins (GA) or cytokinins (6-BAP). Another treatment that increases VL in alstroemerias is 8-HQC, while acidic water (pH 3.5) has also been used as a hydrating solution.

Cut flowers can be stored for two to three days in water at 3–4°C or for a few days at 1°C. Alternatively, they can be stored dry for up to a week at 1–2°C; if pulsed with silver thiosulphate (STS) and sucrose prior to dry storage they may be stored for longer (two weeks at 2–4°C).

Summary of National Cut Flower Centre trials

Overview of the work at CFC

Alstroemeria trials were sited on 1m-wide outdoor beds or beds in a ‘Pro-Tech’ polythene tunnel on a deep alluvial soil at Holbeach St Johns, Lincolnshire. The soil in the polythene tunnel was sterilised with steam the previous October and left sheeted over winter.

Fertiliser applications were according to soil analysis and, although it is not possible to give a base fertiliser recommendation for every cut flower crop, the aim was to bring base levels to those required for column stocks (indices of two for nitrogen, six for phosphorus, four for potassium and four for magnesium).

Plant material was obtained as 7cm and 9cm plug plants from Parigo Horticultural and transplanted at 5/m^2. After establishment, irrigation water was generally applied through lay-flat tubing and plants received a liquid feed at every watering. Three layers of support net were provided. Preventative and curative plant protection products were applied as appropriate.

During the examination of post-harvest quality, simulated grower, transport, depot and retail phases were undertaken first (taking about five days in total), followed by the actual VL test under simulated consumer conditions; the VL figures quoted are the number of days the flowers last in the vase itself, not of the whole period from picking.

Alstroemeria evaluation trial (2014–2017)

Plug plants of alstroemeria cultivars ‘Apollo’, ‘Avanti’, ‘Bonanza’, ‘Candy’, ‘Dana’, ‘Flaming Star’, ‘Friendship’, ‘Golden Delight’, ‘Nina’, ‘Orange Supreme’, ‘Pink Sensation’ and ‘Tanya’ were transplanted into beds in a polythene tunnel or outdoors in weeks 22 and 23, respectively, during 2014. The planting density was 5/m^2.

One layer of support netting was provided initially, increased to three layers after the first year.

Over the first winter only, a layer of peat mulch was applied to the outdoor beds. As is usual with alstroemeria production, vegetative and weak stems were removed at the start of each season to encourage stronger growth, and flower heads were removed until stems started to reach the specified 60cm length.

Figure 5. Cut flower product from the CFC trials

‘Apollo’

‘Avanti’

‘Bonanza’

‘Candy’

‘Dana’

‘Flaming Star’

Figure 6. The 12 tunnel-grown cultivars from the alstroemeria evaluation trial

‘Friendship’

‘Golden Delight’

‘Nina’

‘Orange Supreme’

‘Pink Sensation’

‘Tanya’

Figure 6. The 12 tunnel-grown cultivars from the alstroemeria evaluation trial (*continued*)

Once buds started to show colour, stems were picked at that stage half-weekly, weekly or fortnightly, according to the state of the crop.

In the tunnel, plant establishment was good. After a period of removing weak stems, marketable flowers were produced from week 31 in all 12 cultivars. These plants were vigorous and produced good, strong stems.

Outdoors, the plants were slow to develop and the flowering stems were less numerous, but nevertheless the first stems were picked in all cultivars in weeks 33 or 34.

In both the tunnel and outdoor plots, picking continued in all cultivars until weeks 44–45, when picking was brought to an end to allow the tunnel to be deskinned for the winter.

The tunnel crop overwintered well into 2015, and started producing shoots for thinning as soon as the tunnel was covered in week 17.

Marketable stems of high quality were picked commencing weeks 23 to 26 (cultivar-dependent), one to two months earlier than the first year.

In the outdoor plots, marketable stems were cropped commencing between weeks 26 and 28, although overall growth was less vigorous than under protection.

Marketable flowers were still being produced in the tunnel when cropping ceased for tunnel deskinning (week 44), while the last pick outdoors was in week 41.

This strong performance continued into 2016. Marketable stems were picked from weeks 22 or 23 in the tunnel and from weeks 26 to 29 outdoors. Marketable flowers were still being produced in the tunnel and outdoors when cropping ceased for deskinning (week 41).

In the year of planting, there was a slow build up of marketable stem numbers, with most picking occurring in the second half of the season from week 31 onwards with cyclical peaks (combined tunnel and outdoor crops) in weeks 35, 38, 41 and 43.

In the second and third years, there was a shift towards earlier picking (from weeks 22/23) and a rapid build to the main picking period with production peaks during weeks 27, 32, 35, 37 and 41 in 2015 and weeks 26, 29, 33, 36, 38 and 40 in 2016.

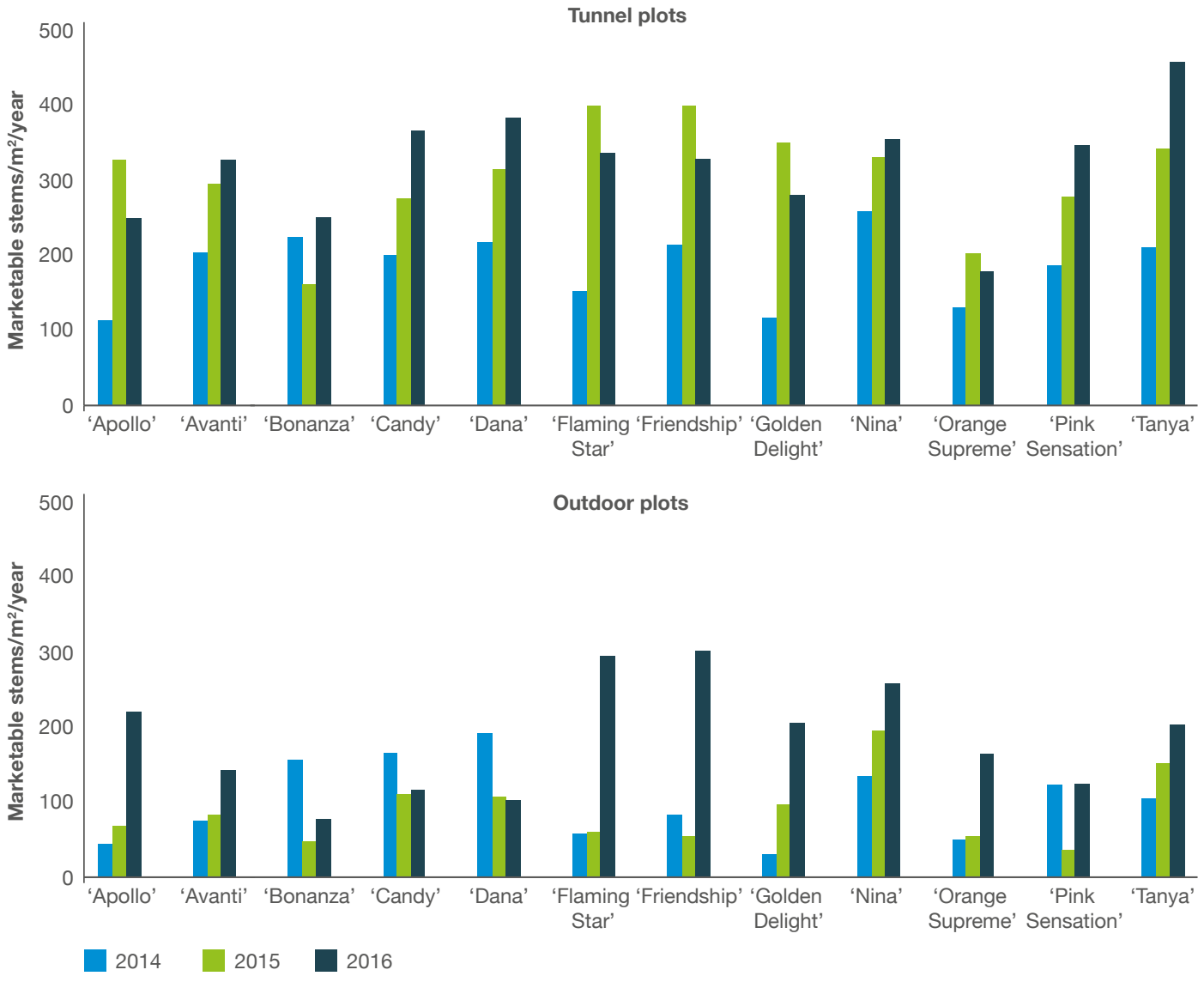

Figure 7. Marketable stems per m^2 per annum for each of the cultivars grown under protection and outdoors in the three-year CFC project

With the combination of 12 cultivars in tunnel and outdoor plots, the supply of flowers was reasonably consistent and occurred over a long, five-month period, though there were still a few weeks each year when no flowers were available, typical of the cycling that occurs in alstroemeria flower production.

These gaps in supply need to be remedied, perhaps by growing new plantings alongside older ones, by a small number of sequential plantings or by the greater use of cold storage to hold back supplies when they are abundant.

The yields of individual cultivars varied markedly: overall 'Nina', 'Tanya', 'Friendship', 'Dana' and 'Flaming Star' were the most productive, and 'Orange Supreme' and 'Bonanza' the least. Under protection, 'Nina' was the most productive in the first year, 'Flaming Star' and 'Friendship' in the second year and 'Tanya' in the third year. Outdoors, 'Dana' was the most productive in the first year, 'Nina' in the second and 'Friendship' and 'Flaming Star' in the third. Under the polythene tunnel, half of the cultivars peaked in the second year and half in the third. Outdoors, two-thirds of the cultivars peaked in the third year and the others in the first.

Overall, yields in the tunnel were more than double those of outdoor crops. Annual production steadily increased over the three years. In approximate terms, tunnel-grown crops produced about twice the yield of the outdoor crops in the first and third years, and about treble the yield in the second year.

In week 29 of 2014, stems of eight cultivars were sampled for standard VL testing. They had a consistent average VL of 12 days, thereby greatly exceeding the usual number of 'guaranteed days'. By the thirteenth day of the test, flower petals were dropping and foliage was senescing. It appeared important to allow alstroemerias to show good colour before picking, as this makes them much more attractive and does not appear to shorten their VL.

Conclusions from the trial work

- Alstroemerias are conventionally seen as a relatively sophisticated AYR crop grown under good-quality glass, using the wide range of improved cultivars available from specialist breeders. The planting material is relatively costly however, as it is derived from micropropagation and is subject to the restrictions imposed by PBR
- The increased availability of low-tech polythene tunnels for crop protection and seasonal extension provided a potential option to grow a summer crop of older or garden cultivar alstroemeria that were not subject to PBR or for which PBR had expired
- Since alstroemeria cultivars can vary considerably in performance, and it is not always easy to identify non-PBR cultivars, careful research is needed to identify suitable cultivars
- Twelve commercial cut flower and standard garden cultivars, none the subject of PBR, were planted in beds in a polythene tunnel or outdoors at 5 plants/m^2 in weeks 22 or 23 of 2014, and grown for three years. Tunnel-grown plants established and overwintered well, producing good yields of long, marketable stems of surprisingly good quality and with a VL of around 12 days. In general, stem yields increased or were maintained over the three years of the trial. The results confirmed the concept of growing a summer crop of alstroemeria under relatively low-tech conditions
- Equivalent plots in outdoor beds gave lower yields, but their quality was still acceptable and the production system may work well for some smaller cut flower businesses
- With a combination of 12 cultivars growing under polythene and outdoors, flower picking extended over a five-month period. There were some gaps in production, but it is likely that cropping could be made more continuous by using a short run of sequential plantings and planting in successive years, in addition to using multiple cultivars and protected- and field-production
- Alstroemeria cultivars outside of PBR could be propagated from the vigorous, rhizome-like tubers after a flower production cycle to form a stock for growing-on

Further information on the National Cut Flower Centre project and trials work

Further details can be found in the following project reports, available from either the AHDB Horticulture website **horticulture.ahdb.org.uk** or the CFC website **http://www.thecutflowercentre.co.uk**

- Annual reports on AHDB Horticulture Project PO/BOF 002a (2013-2016): The National Cut Flower Trials Programme for 2013-2017
- Annual and final reports on AHDB Horticulture Project PO/BOF 002 (2010-2012): The National Cut Flower Trials Programme for 2010-2012
- Final report on AHDB Horticulture Project PC/BOF 268a (2009): Establishing a trials centre for the cut flower sector
- Annual and final reports on AHDB Horticulture Project PC/BOF 268 (2008): Establishing a trials centre for the cut flower sector

The industry-led National Cut Flower Centre was set up at Kirton Research Centre, Kirton, Lincolnshire in 2007 with the support of AHDB Horticulture and Lincolnshire Fenlands LEADER+. In 2009, with AHDB Horticulture funding, the CFC moved to a dedicated site at Rookery Farm, Holbeach St Johns, Lincolnshire. The basic remit of the CFC is the stimulation of UK polythene tunnel and field-grown cut flower production through providing know-how from practical trials carried out under UK conditions.

Authors

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