

Lisianthus (*Eustoma grandiflorum*) as a cut flower crop grown in polythene tunnels

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Grower summary

- Lisianthus (*Eustoma grandiflorum*) are one of the top selling cut flowers in the world, but all UK supplies are imported. Trials at the National Cut Flower Centre (CFC) have shown that high-quality summer spot crops could be grown from plug plants in Spanish tunnels.
- At the CFC, lisianthus were grown in soil previously sterilised with steam or Basamid (dazomet) or left un-sterilised. Visually, crops looked better in the steam-sterilised soil, but there was no quantitative advantage of growing in sterilised soil. However, since lisianthus are susceptible to many stem and root pathogens, soil sterilisation would still be recommended as 'good practice'.
- Many series of lisianthus cultivars are available, enabling production over an extended season. For summer or autumn production under tunnels, plant cultivars of groups II or III in weeks 9 to 26 (group II) or 16 to 26 (group III). Cultivars from many series performed well in CFC trials, with stems achieving a specification of 70 cm length and 80 g trimmed weight.
- Plug plants crop within two to four months, depending largely on temperature. Outdoors, three plantings can begin once any danger of frost is past. In one trial at the CFC, plug plants of a wide selection of cultivars were transplanted from week 18 to 20 and flower picking started from week 30 onwards.
- Planting densities of 64 to 96 plants/m² are recommended and most of the plantings in the CFC trials were at 64 plants/m². Wider spacing produce stronger, heavier stems, but the difference is relatively small. CFC trials showed that planting through a plastic film mulch gave little or no benefit.
- As a guide, a suitable glasshouse temperature for growth is 20°C day and night (with night temperature later reduced to 17°C). Cooler growing increases stem length and diameter, but delays development. More florets may be produced under high light intensity, but this will result in less intense flower colours. Growing in Spanish tunnels avoids damage from rain (petal spotting), but ventilation is important to prevent high humidity levels. At the CFC, better quality flower stems and less pest and disease was seen in a 'closed' tunnel equipped with side-skirts and end-doors, compared with an 'open' tunnel.
- Lisianthus require relatively little water at first. Although benefiting from uniform irrigation, they are sensitive to wetness and high humidity. Irrigation should be 'little and often' and reduced when the stems are sufficiently long. In wet conditions, production on raised beds is advisable.
- Lisianthus grow at a relatively higher pH than many other flower crops, 6.5 to 7.2, with both lower and higher pH being detrimental to quality. High nitrate and potassium fertilisation is required for good growth. Use a higher rate of nitrate before bud formation and a higher rate of potassium thereafter; discontinue feeds as buds become visible. Watch for leaf tip-burn, a result of calcium deficiency.



1. Lisianthus is one of the top selling cut flowers in the world

- Use one or two layers of support netting. Pinching causes shorter stems and delays flowering. Plants should be cut-back after picking to encourage a good second flush of growth.
- A wide variety of pests and diseases affect lisianthus, though in trials at the CFC no serious damage was encountered when plants were grown in a 'closed' tunnel.
- Flowers should be picked when they are dry and conditions cool. The recommended picking stage varies from when one floret is fully coloured, to having two or three buds open and a few coloured. Petals and foliage are susceptible to both bruising and *Botrytis*.
- Preferably, place the flower stems in water in a well-lit, cool store with low humidity, re-cutting stems and placing them

upright in a pre-treatment solution containing sugar and an antimicrobial treatment. Store at 2 to 5°C with good air circulation and avoid high humidity levels.

- The vase-life guarantee for straight lisianthus is usually nine days, in standard vase-life tests at the CFC various cultivars achieved vase-lives of between six and 14 days. In mixed bouquets, lisianthus is generally guaranteed for five or seven days, a criterion nearly all samples met during trials at the CFC.
- The positive responses of supermarkets and packers to the lisianthus grown at the CFC indicated it would be worthwhile for growers to consider lisianthus as a tunnel-grown summer crop.

Introduction

Eustoma grandiflorum (sometimes called *E. russellianum*), the 'Texan bluebell', is an annual or biennial native to Colorado, Kansas, Nebraska and Texas. In summer the plants produce bell-shaped, satin-textured, pale purple flowers with darker centres, singly or in clusters. This species has been extensively hybridized over the last 20 years to produce a host of series, each with its own colour variants, and stand-alone cultivars. The colours include pink, purple, red, white and yellow and some combinations, singles and doubles, with variations in patterning and a range of seasonality. Cultivars are either tall (60 to 90 cm) cut flowers for production under glass or in the

field, or short with multiple stems for pots. There are even new formats, such as the 'Mono Lisi' (from Montana Lisianthus) with individual florets made into posies.

With their exotic looks, lisianthus are one of the top-selling flowers in the world, and are enjoying a surge of popularity in Europe and North America. In the UK they have been almost entirely imported, and, despite their reputation for being difficult to grow, production closer to markets would be advantageous. In fact many of these difficulties lie in the propagation stage, and most growers will buy in mature plug plants.

Cultural requirements and production methods

Not all aspects of lisianthus growing could be covered in the CFC trials, and the following summary has been compiled from textbooks, research findings and seed and young plant suppliers' cultural notes. This is followed by a summary of the CFC trials.

Cultivars

Cultivars from many series were included in the Association of Specialty Cut Flower Growers (www.ascf.org) national field trials, with favourable results. Some examples of series found in catalogues are listed in Table 1. To assist in scheduling, lisianthus are classified into seasonality groups, and the numerals included in some series names indicate their season of use. For glasshouse growing in northern Europe under natural light, one system uses three groups, I, II and III, for winter, spring and summer planting, respectively (supplementary lighting would be needed to achieve all-year-round production). Under glass, from planting to cropping takes 10 to 12 weeks. For summer/autumn production in polythene tunnels, cultivars from groups II (planting in weeks 9 to 26) and III (planting weeks 16 to 26) should be used.

Scheduling

Plug plants elongate and crop within two to four months, depending on conditions. From visible bud to open flowers takes one to two months, depending on temperature. Lisianthus are quantitative long-day plants, flowering even in eight hour days but faster under long days, however, the growing temperature is more important. Outdoors, three plantings can begin once there is no danger of frost, for example during mid-

April, mid-May and mid-June. Under glass an all-year-round production can almost be achieved if assimilation lighting is used for plantings between July and December.

Propagation

From sowing to a plug plant with three to five pairs of leaves takes two to three months, during which temperature, irrigation and the control of substrate-borne and other pathogens are critical, but this is an operation normally undertaken by specialist plant raisers so will not be detailed here. Temperatures above 22°C inhibit stem elongation and cause resetting, and trays of smaller or rosetted plants should not be accepted. Plug plants can be transplanted on into 48 cell trays to continue growth before planting if required.

Transplanting

The recommended planting density for mature plug plants under glass is 64 plants/m² in winter, rising to 84 to 96 plants/m² in summer.

Growing conditions

After the propagation stage, higher temperatures (to 27°C) no longer inhibit flowering, though some recommend that under glass higher temperatures should be avoided for the first four weeks, growing at 20°C day and night and later reducing the night temperature to 17°C. Cooler growing increases stem length and diameter, but delays development. Other recommendations include a night temperature of 15°C for early crops, rising to 20°C for late crops, with corresponding

day temperatures of 17 rising to 22°C. High humidity levels should be avoided. There is some benefit of growing under long days, but even differences between growing under short winter days or with night-break or day-length extension are small. Plants may produce more florets under high light intensities, but higher intensities may result in less intense flower colours. In the field, the use of shading is debatable: in bright sunlight shading increases stem length, but reduces floret number and stem diameter. Damage from rain causes petal spotting, so production in a Spanish tunnel is a good option.

Table 1. Some lisianthus series for cut flower production

Series name	Notes
'ABC 1, 2, 3'	Double, group I, II and III, less rosetting, good vase-life
'Adorn'	Single, group III
'Advantage'	Double, group II, long stems even under high temperatures and long days
'Alissa'	Double, recent introduction
'Arena'	Double, large to small-flowered, group II and III, good in transport
'Borealis'	Double, very early, less blindness
'Ceremony'	Double
'Cessna'	Double, group II and III
'Charm'/'Charm-Mirage'	Single, group III
'Chroma'	Double, small-flowered, group III, good in transport
'Cinderella'	Double, voluminous florets, group II
'Dream'	Double
'Echo'/'Echo-Dream'/'Dream'	Double, spray type
'Excalibur'	Double, group II and III, less rosetting, good vase-life
'Falda'	Single, fringed petals and voluminous florets, group III
'FleurElisa'	Double, recent introduction
'Kyoto'	Single
'Laguna'	Single, group II and III
'Magic'	Double, group II
'Mariachi'	Double, camellia-headed, group II, good in transport, often used for outdoor production in the USA
'Minuet'	Double, small-flowered, group II
'Paloma'	Single
'Papillon'	Double, small-flowered, group III
'Piccolo 1, 2, 3'	Single, small-flowered, group I, II and III, good in transport, <i>Botrytis</i> resistant, good vase-life
'Revolution'	Double, group II
'Rosanne'	Single, recent introduction
'Rosita 1, 2, 3'	Double, small-flowered, group I, II and III, good vase-life
'Super Magic'	Double, group II
'Vulcan'	Single, small-flowered, group III, spray type, good in transport, good vase-life
'Wonderous' [sic]	Single or double, group I, good vase-life

Stand-alone cultivars not included; list compiled largely from the current Combinations, J van Egmont, Florensis Cut Flowers, Fred Gloeckner, Montana Lisianthus, PanAmerican Seed, Sakata and Takii catalogues.

Nutrition and irrigation

Lisianthus grow slowly at first and require relatively little water. Yield and quality benefit from uniform irrigation but the crop is sensitive to wetness and high humidity, and irrigating 'little and often' is preferred, though the soil should not be allowed to dry out. Irrigation should be reduced when the stems are sufficiently long, maintaining this regime during flowering. In wet conditions outside, good drainage and production in raised beds are advisable.

Lisianthus grow at a higher pH value than many other flower crops, 6.5 to 7.2. A pH below 6.0 is damaging and above 7.0 can reduce the intensity of flower colour. High nitrogen and potassium fertilisation are required for good growth, using a 15:0:15 N:P:K fertiliser with the nitrogen element supplied as nitrate. Using a higher rate of nitrogen before bud formation and a higher rate of potassium thereafter has been recommended. When growing outdoors a three month slow-release fertiliser has been recommended. Calcium deficiency leads to tip-burn on young leaves, requiring an application of a calcium feed. Feeds should be discontinued as buds become visible.

Plant manipulation and support

One or two tiers of support can be used, depending on conditions. Pinching causes shorter stems and delays flowering. To encourage a good second flush, plants should be cut back after the first picking.

Pest and disease control

Aphids, thrips, whiteflies and leaf miners cause significant damage in their own right, and the first three of these are also vectors for viruses. Viruses cause the usual symptoms - leaf yellowing, mottling, chlorosis and distortion and poor flowering. Tomato spotted wilt and impatiens necrotic spot viruses are spread by thrips, bean yellow mosaic virus by aphids, tomato yellow leaf curl virus by whiteflies, and tobacco mosaic virus by humans. Fungal diseases include *Botrytis* (grey mould), *Fusarium*, *Myrothecium*, *Peronospora* (downy mildew), *Phytophthora*, *Pythium* and *Thielaviopsis*. Poor drainage combined with hot or humid weather can lead to major problems with root rots and stem blight (*Sclerotinium rolfsii*).

Picking, specifications and packing

Good growing conditions should give ten or more buds on four to six stems per plant. Some growers remove any small flower buds as the terminal bud starts to open (small buds may fail to open), while others remove the central bud causing more to open simultaneously. Lisianthus should be picked when the flowers are dry. Specifications vary, one stating that stems should be cropped when one floret is fully coloured but not necessarily fully open, others that at least one floret should be open, one three-quarters to fully open, and a third starting to open and showing colour, or again, two or three buds open and a few buds coloured. Lisianthus should be cropped in the morning when they are cool, and the stems should be placed in water in a cool store soon after picking. The petals and foliage are susceptible to both bruising and *Botrytis* and should be checked.

Post-harvest care

To avoid bending, stems should be re-cut and placed upright in a pre-treatment solution containing sugar. They should be stored at 2 to 5°C in a well-lit cold store with good air circulation, avoiding high humidity. The flowers produce significant amounts

of ethylene, so other ethylene-sensitive flowers should not be stored with them. Pre-treatments and flower conditioners should be used to increase vase-life and/or open more florets. Many types of 'preservatives' have been reportedly used successfully, though good treatments include a continuous use of 2 to 4% sugar or pulsing with 10% sugar, plus an antimicrobial

material. The use of 'anti-ethylene' compounds is considered probably unjustified, although lisianthus become increasingly sensitive to ethylene with age. The vase-life of fresh stems is quoted as between seven and 15 days. Colours, especially blue and pink, may fade under low light, though this can be remedied by increasing light intensity.

A summary of the National Cut Flower Centre trials work

Overview of work at the CFC

Trials were sited on 1 m wide beds in 'Haygrove' or 'Pro-Tech' polythene tunnels on heavy silt at Holbeach St Johns, Lincolnshire. The soil had been previously sterilised by steam or Basamid (dazomet), except that the 2012 trial called for some non-sterilised as well as sterilised areas. 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). Lisianthus were obtained as plug plants from Florensis Cut Flowers and transplanted through black polythene film at 64 plants/m² into trial pots about 3 m long. Support netting was provided. Once established, water was applied through lay-flat irrigation. Once in growth, plants received a weekly liquid feed, increasing to twice per week for lisianthus planted later in the season. In 2012 only, a phosphate fertiliser and growth stimulant ('Nutri-Grow': 4:30:8 N:P:K) was applied to lisianthus at 0.45 kg/ha in week 26. Preventative and curative crop protection products were applied as appropriate.



2. Young lisianthus plants in trials at the CFC

The details of postharvest testing varied, but usually there were simulated grower, transport, depot and retail phases (four to five days in all) followed by the vase-life test itself under simulated consumer conditions.

Preliminary evaluation of lisianthus in polythene tunnels

In 2010 a wide selection of cultivars was grown as a summer spot crop in polythene tunnels: 'ABC 2-3 Rose', 'Arena Blue', 'Dream White', 'Kyoto Purple', 'Paloma Yellow', 'Piccolo Apricot', 'Pink Picotee'

and four from the 'Mariache' series – 'Lime Green', 'Misty Pink', 'White Pure' and 'Yellow'. In weeks 18, 19 and 20 plug plants were transplanted into beds in a 'Haygrove' tunnel fitted with side skirts and end-doors to provide additional protection (without such protection stem breakage would occur in windy weather conditions). The plants grew well and started cropping in week 30, continuing beyond a CFC Open Day in week 34 at which visitors acknowledged the results were impressive. The blooms had high stem strength and showed no pest and disease problems. Many samples were provided to industry for assessment. But since the summer of 2010 had brought warm, dry weather favourable to lisianthus, this result could have been simply fortuitous: further investigations were needed to confirm or challenge the result.

Lisianthus performance in 'closed' and 'open' polythene tunnels

27 different cultivars were trialed in 2011, some from the series grown in 2010 and some representatives of other series including: 'Ceremony', 'Excalibur', 'Minuet', 'Papillon', 'Revolution' and 'Rosita'. Plug plants of 10 cultivars were transplanted into the 'closed' 'Haygrove' tunnel in weeks 18, 19 and 20. Further plug plants of the 10 varieties planted in week 20 were planted into an 'open' 'Pro-Tech' tunnel in week 21.

Despite the wetter, cooler weather in 2011, the plots in the 'closed' tunnel again produced strong, high-quality stems with only inconsequential pest or disease levels and little evidence of root diseases. In contrast, growth of those plantings in the 'open' tunnel was weak, and a significant incidence of *Fusarium* was seen, along with some *Pythium*. Unfortunately the cover was blown off from the 'open' tunnel before flowering, so an earlier planting would have been beneficial.

With such a range of cultivars there were considerable varietal differences in cropping dates, stem lengths and stem weights. Some cultivars were evidently more suited than others to cultivation in tunnels. Most cultivars planted in weeks 18 and 19 cropped in weeks 32 and 33, respectively, only a few cropping later. The week 20 plantings cropped over a longer period, weeks 32 to 36. Only eight of the plantings in the 'closed' tunnel failed to reach the specified length needed for trimming (70 cm), and only six had a trimmed stem weight of less than 80 g each. Table 2 lists the tested cultivars that were satisfactory in all these respects, and those that were later to crop or had shorter or lighter-weight stems. Stem lengths and weights averaged across the cultivars showed no obviously detrimental effects due to later planting.

Table 2. Performance of cultivars in the 2011 CFC lisianthus trial in a ‘closed’ tunnel

Cultivars proving satisfactory	Later, shorter or lighter cultivars
‘ABC 2-3 Blue Rim’	‘Dream Blue’
‘Arena III Red’	‘Dream Lavender’
‘Arena Rose’	‘Dream White’
‘Arena White’	‘Kyoto Purple’
‘Ceremony Blue Flash’	‘Mariachi Lavender’
‘Excalibur Green’	‘Mariachi Lime Green’
‘Excalibur Pure White’	‘Minuet Apricot’
‘Excalibur Yellow’	‘Papillon Flash Pink’
‘Mariachi Blue’	‘Papillon Rose Pink’
‘Mariachi White Pure’	‘Revolution Green’
‘Minuet Dark Purple’	‘Revolution White’
‘Minuet White’	
‘Piccolo 2 Deep Blue’	
‘Piccolo 2 Rose Pink’	
‘Rosita 3 Yellow’	
‘Rosita Blue’	



3. Selection of cultivars from trials at the CFC

Further lisianthus trials

The results of the previous trial were positive in terms of the potential to produce tunnel-grown lisianthus in the UK. They also raised a number of issues that were addressed in 2012 through a further trial. The trial treatments were combinations of several factors: ‘open’ and ‘closed’ tunnels, soil sterilisation, planting density, mulch use and cultivar selection.

Plug plants of 13 cultivars were planted in the ‘closed’ tunnel in week 21 and in the ‘open’ tunnel in week 22.

The cultivars used covered a good range of series: ‘Arena Yellow’, ‘Ceremony Blue Flash’, ‘Charm White Blue’, ‘Excalibur Green’, ‘Magic Lilac’, ‘Mariachi Blue’, ‘Minuet Dark Purple’, ‘Papillon Flash Pink’, ‘Piccolo 2 Rose Pink’, ‘Piccolo 2 White Pure’, ‘Rosita 3 Pink’, ‘Velvet Purple Summer’ and ‘Vulcan 1 Green’.

‘Open’ and ‘closed’ tunnels and soil sterilisation

In 2011 different levels of pest and disease had been found in the ‘open’ and ‘closed’ tunnels. However, this might have been due to the different methods of soil sterilisation used, rather than a difference in microclimate. In 2011 both tunnels had been sterilised with Basamid (dazomet), but the ‘closed’ tunnel had been treated in autumn 2010 and left sheeted over winter while the ‘open’ tunnel had not been treated until spring 2011. So in 2012 the treatments examined included:

- ‘closed’ tunnel not sterilised;
- ‘closed’ tunnel sterilised with steam and left sheeted with polythene over winter;
- ‘closed’ tunnel sterilised with Basamid and left sheeted with polythene over winter;
- ‘open’ tunnel sterilised with steam and left sheeted with polythene over winter.

The overall stem quality in the ‘closed’ tunnel was exceptional, with little disease. Cropping started in week 33. Plants in the ‘open’ tunnel were very slow-growing many failing to reach flowering before the tunnels were de-skinned. There were some root problems but no significant crop losses. So, unless there is a very warm summer, the production of lisianthus in tunnels should only be considered where there is the facility to close the doors and sides to ensure an adequate temperature is achieved.



4. A range of lisianthus cultivars grown in a ‘closed’ tunnel

Plants in steamed plots produced visually better stems, while sterilisation with Basamid had an adverse effect on stem length and weight in some cultivars, but there were no consistent benefits of soil sterilisation on growth or quality. Despite this, soil sterilisation probably remains good practice.

Planting density

In the Netherlands, lisianthus are planted at high densities to achieve commercial viability, so planting rates of 64, 80 and 96 plants/m² were included. Stem weights were greatest at the lowest rate, but the size of the response varied between cultivars. Stem lengths were broadly consistent throughout. Using the highest density may reduce stem weight in some cultivars.

Mulch

The possible benefits of growing lisianthus through polythene mulch had been raised in discussions in 2011, so mulched and non-mulched plots were included. The mulch was a micro-perforated black polythene film. In the 'closed' tunnel, planting through mulch did not increase stem length or weight compared with planting directly in the soil, while in the 'open' tunnel there was a small positive benefit of using mulch on stem length, but not weight. So using mulch in this way has little benefit.

Cultivars

The between cultivar differences in stem quality were larger than differences between tunnel type, soil sterilisation methods, planting density and using or not using mulch, therefore cultivar selection is very important.

Vase-life testing

In 2011 sample bunches from 13 cultivars were picked from the trial for standard vase-life testing, the cultivars achieving vase-lives from seven to 14 days. In 2012, 12 out of the 13 samples achieved a vase-life of between six and nine days. The end of vase-life was mainly due to flower-head damage as a result of *Botrytis* and wilting of the flowers and stems. The vase-life guarantee for straight lisianthus is usually nine days, and of the 26 samples only seven achieved this. Lisianthus is also used in mixed bouquets generally guaranteed for five or seven days, a criterion all but one sample met.

Conclusions from the trial work

- Three years of trials showed that a 'Haygrove' tunnel fitted with side-skirts and end-doors made a suitably protective environment for growing high-quality stems of a wide range of lisianthus series and cultivars. Production in an 'open' tunnel may be feasible in warm years.
- Visually, crops looked best in steam-sterilised soil, but surprisingly there was no quantitative advantage of growing in sterilised (steam or Basamid) soil over non-sterilised soil. Since lisianthus are susceptible to many stem and root pathogens, however, soil sterilisation would still be 'good practice'.
- Planting lisianthus through a plastic film mulch gave little or no benefit compared with planting directly into the bed.
- As would be expected, wider spacing tended to produce stronger, heavier stems, but variations between cultivars were more significant than variations due to planting density or the other factors studied.
- These results and the positive responses of supermarkets and packers to lisianthus grown at the CFC indicated that it would be worthwhile for growers to consider lisianthus as a tunnel-grown crop.
- There is a need for cultivar screening and the development of post-harvest treatments to extend the vase-life of lisianthus as cut flowers.

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

Further details can be found in the following project reports, available from the HDC website or on the National Cut Flower Centre website www.thecutflowercentre.co.uk:

- Final Report on HDC Project PO/BOF 002 (2012): 'The National Cut Flower Trials Programme for 2010-2012'.
- Final Report on HDC Project PC/BOF 268a (2009): 'Establishing a Trials Centre for the Cut Flower Sector'.
- Final Report on HDC Project PC/BOF 268 (2008): 'Establishing a Trials Centre for the Cut Flower Sector'.

The industry-led National Cut Flower Trials Centre was set up at Kirton Research Centre, Kirton, Lincolnshire in 2007 with HDC and Lincolnshire Fenlands LEADER+ support. In 2009, with HDC funding, the CFC moved to a dedicated site at Rookery Farm, Holbeach St Johns, Lincolnshire. The 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.

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