

Snapdragons (*Antirrhinum majus*) as a cut flower crop grown in polythene tunnels

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Grower summary

- Cut flower antirrhinums (snapdragons) are usually imported but have potential to be tunnel- or field-grown in the UK.
- Many series have been bred as long-stemmed cut flowers with a good range of colours, often for glasshouse production, but some (including 'Apollo', 'Attraction' ('Axiom'), 'Potomac' and 'Trumpet' cultivars) are recommended for production outdoors.
- As well as types with the characteristic snapdragon florets, peloric ('open-faced', 'butterfly' or 'trumpet') series are available and are attractively different.
- Trials at the National Cut Flower Centre (CFC) showed high-quality conventional and 'Trumpet' cultivars could be produced in Spanish tunnels or outdoors.
- Under tunnels, satisfactory crops were obtained from planting as early as week 14 or as late as week 26, picking some eight weeks after transplanting.
- Many tunnel-grown 'Apollo', 'Potomac' and 'Trumpet' cultivars met the specification for stem weights of 50 g and spike lengths of 20-30 cm, with second-flush flower stems lighter and shorter but often within specification.



1. 'Red' peloric antirrhinum from the CFC trials

- Plug plants should be planted at 64/m² on a slightly raised bed as to avoid waterlogging.
- If planting outdoors with the possibility of frost, ensure plants are hardened-off beforehand.
- Grow plants 'on the dry side' and provide sub-irrigation where possible.
- Grown too warm, the stems are tall and weak and flower spikes shorter (under glass recommendations go up to 24°C).
- Poor light levels can cause blindness in plants.
- Two layers of support netting should be provided.
- Crops at the CFC were not pinched during production.
- Plants are susceptible to grey mould (*Botrytis*) so suitable cultural and chemical precautions should be undertaken.
- Feed once or twice a week from establishment until buds swell.
- The recommended picking stage varies from 30% of bottom florets open, to two to three florets showing colour; at the CFC trumpet types were often picked later to show off the different flower form. Stand stems upright in water promptly.
- The vase-life of traditional and 'Trumpet' cultivars was adequate, about a week, but reduced by late picking.
- Although described as responsive to pre-treatment and conditioning solutions, in the CFC trials they appeared unresponsive.
- Antirrhinums, especially 'Trumpet' cultivars, because of their quality and striking form, present an opportunity for production in the UK, close to markets. But better quality will demand somewhat higher returns.

Introduction

Despite the quantity of information available on growing antirrhinums, and the wide appreciation of the flowers and their colour range, as cut flowers in the UK they have been almost entirely imported. Since the flowers are relatively delicate, production closer to markets would be advantageous. In theory, when grown outdoors, under polythene tunnels and in cold glasshouses, stems could be available 46 weeks of the year.

Antirrhinum majus, snapdragon, is a summer-flowering, short-lived Mediterranean perennial usually cultivated as an annual. Although more familiar in the UK as a bedding plant than as a cut-flower, snapdragons have been bred extensively as cut flowers for all year round production under glass: they are an important glasshouse crop in Western Europe and the USA, and in suitable climates can be grown outdoors from early-spring to autumn. Their stems bear racemes of usually broadly tubular, mildly fragrant, two-lipped flowers with a characteristic hairy palate on the lower lip. Cultivated selections vary from purple, pink and red to white, yellow and bronze, and bicoloured, double ('azalea-type') and peloric ('open-faced', 'butterfly' or 'trumpet') cultivars are also available.

At the CFC the potential for growing antirrhinums in tunnels was examined, and grower interest was considerably stimulated by the arrival in 2009 of a new series of stunning peloric cultivars which, instead of the familiar bilaterally symmetrical florets, produced open-faced, radially symmetrical florets. (The term peloric refers to the occurrence of radially symmetrical florets in a genus that characteristically has bilaterally symmetrical

florets.) At the time these were regarded as an improvement over existing cultivars because of their stronger stems, large florets and tolerance to transport, and in 2013 PanAmerican Seed released two cultivars from the 'Trumpet' series, 'Trumpet Pink' and 'Trumpet Tangerine'. Some other cultivars are also peloric, such as the 'Apollo' and 'Chantilly' series. Peloric snapdragons are not new, what is new is the cut-flower quality of the 'Trumpet' series.



2. This pink 'off-type' illustrates the difference in form between traditional and peloric antirrhinums

Cultural requirements and production methods

Not all aspects of snapdragon growing could be covered in the CFC trials, and the following summary of production methods 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

Many suppliers offer dwarf (15-30 cm high), intermediate and tall cut-flower (75 cm plus high, but usually 100-150 cm) types. Some intermediate, bedding types may be marginal for cut flower use, such as the 'Coronette' and 'Tetra' series with stems up

to 70 cm high. Many series are listed in the current catalogues for cut flower production, generally for the glasshouse, but with some listed as suitable for growing outdoors (Table 1).

For glasshouse production, cultivars are classified into response groups (to temperature and day-length) for harvest in specific seasons, though seasonality may vary between the cultivars even within a series. There is little experience of growing cut flower snapdragons in the UK, and, while seed and young plant suppliers may recommend a series for particular uses, it is likely that many would need to be trialled to determine their suitability for growing outdoors or in tunnels.

Table 1. Some antirrhinum series for cut flower production

Series	Notes
'Admiral'	
'Allure'	
'Animation'	
'Apollo'	Suitable for outdoors. Peloric
'Appeal' ('Paxia')	Suitable for outdoors
'Attraction' ('Axiom')	Suitable for outdoors
'Bali'	
'Calima'	
'Chantilly'	Peloric
'Charming'	
'Connexion'	Suitable for outdoors
'Cool'	Suitable for outdoors
'Costa'	
'Early Potomac'	Suitable for outdoors
'Exquisite'	
'Glorious'	
'Maryland'	Suitable for outdoors. 'Purple Twist' and 'Red Delilah' are 'stand-alone' cultivars that can be treated like this series
'Monaco'	Suitable for outdoors
'Opus'	
'Overture'	
'Potomac'	Suitable for outdoors
'Premier'	
'Rocket'	Suitable for outdoors. Shorter (75-90 cm)
'Sunshine'	
'Super'	
'Supreme'	
'Trumpet'	Suitable for outdoors. Peloric

List compiled largely from the current BallColegrave, Combinations, Florensis, Fred Gloeckner, Kieft Seeds, PanAmerican Seed, Sakata and Takii catalogues.

Scheduling

Antirrhinums are quantitative long-day plants, meaning flowering is earlier under long days and later under short days, but many modern cultivars are virtually unaffected by day-length and (with suitable temperatures) grow at any time of year. Outdoors a few sowings are made, under glass sowings may be made weekly. The choice of cultivar is the main factor in terms of scheduling.

Propagation

Published recommendations vary greatly regarding the best germination and growing-on conditions, seed or young plant suppliers should be consulted for specific recommendations. The small seeds (6,000-9,000/g) are sown into plug trays and germinated at 4°C for two weeks before moving to 22°C and high humidity, according to one source, others giving temperature ranges between 18 and 24°C. Most protocols recommend that seed is not covered, or only lightly; some cultivars germinate better in light. Misting (in summer) or a polythene film cover should be used to retain moisture. Antirrhinums is very sensitive to high 'salt' levels in the growing medium, especially of ammonium. Plug plant production time

is four to five weeks. Young plants can be stored for up to six weeks at 0.5 to 4°C if enclosed in polythene film under fluorescent light (2.7 klx for 14 hr/day).

Transplanting

Plug plants can be transplanted once they have three to five true leaves. For transplanting into an unheated environment when frosts are possible, plants should be hardened-off by placing them outside in the daytime or in cold-frames during the day and night, which may allow survival at -4 to -2°C. In the field or under high light levels a planting density of between 64 to 106 plants/m² has been recommended. Some other recommendations for spacing outdoors are much lower (23 to 30 cm within rows with three rows along a 90 cm-wide bed).

Growing conditions

There is no vernalisation requirement and if plants are grown at 10°C or less floral initiation and cropping are late. Under glass, day and night temperatures have been given as 13 to 24°C and 7 to 14°C, respectively. Growing warm leads to stretched plants with reduced spike length and stem strength. Warmer temperatures initially followed by lower temperatures later may give heavier stems. Long days are not necessary, though 12 to 16 hour days ensure flowering. Good light levels are desirable since low intensity leads to blind shoots, though shading with a suitable material gives longer stems and better flowering and the absence of bees reduces the petal shatter that follows pollination. Glasshouse growers may provide 900 to 1,200 ppm CO₂ in winter.

Nutrition and irrigation

Outdoors, side-dress with fertiliser once temperatures warm-up and increase the level of nitrogen with rising temperatures. Under glass, a complete liquid feed (150 to 200 ppm nitrogen and potassium, low in ammonium) should be applied at each irrigation (double the concentration if feeding once a week) until the buds start to swell. Several specific mineral deficiencies have been described. The soil should be well drained and well aerated and advice is to grow the crop 'on the dry side'.

Plant manipulation and support

When grown under glass, plants require two layers of support, the lower one being at a height of 30 cm. Plants may or may not be pinched.

Pest and diseases control

Insecticides and fungicides are likely to be needed. Aphids, caterpillars and two-spotted spider mites are the main pests. Downy mildew, grey mould (*Botrytis*) and rust can be troublesome, so avoid overhead watering and high humidity levels. Debris removal is important for grey mould control, while rust can be reduced using rust-resistant cultivars and lower planting densities.

Picking, specifications and packing

The picking stage is variously when 30% of the bottom florets are open and the top buds are showing colour, or when five to seven florets are open. For longer storage, or when using a 'preservative' (pre-treatment, hydrating or processing) solution, stems can be picked with as few as two or three florets showing colour.

Post-harvest care

The literature indicates that few cut flower crops are more responsive to good post-harvest treatment than snapdragons. Post-harvest life and quality depend largely on cultivar selection, temperature and whether a preservative solution is used.

One supplier recommends that stems should be stood immediately after picking in warm (21-25°C) water with added preservative and kept at 7 to 10°C overnight. Antirrhinum flowers are sensitive to ethylene, so an 'anti-ethylene' pre-treatment solution may be helpful, while the use of a preservative containing sugar plus biocide has been reported to increase vase-life from eight to 21 days. Fresh stems can be stored for five to eight days in plain water (longer using a preservative). Stems can be stored at 4°C for three to four days

either dry or wet, or up to 10 days in a plastic film wrap; where stored dry, a rehydration solution should be used before transport. At 0 to 2°C storage can extend to one to two weeks.

The stems are phototropic and geotropic, so should be stored and shipped upright (and in good light if possible) to help prevent bending. When stored for more than four days, grey mould may be a problem. Elevated CO₂ levels have been investigated in storage as an alternative to chemical control of pests. Refrigerated transport is best, while warmth (in loading bays, etc.) is to be avoided. To improve flower quality after longer storage, a vase solution or cut-flower food should be used and stems should be stored at 21°C and about 80% RH, under high light levels and 16 hour days.

A Summary of the National Cut Flower Centre trials work

Overview of the work at CFC

Trials were sited on 1 m wide outdoor beds or beds in 'Haygrove' or 'Pro-Tech' polythene tunnels on medium silt soil at Kirton, Lincolnshire (up to 2008) or on a heavier silt at Holbeach St Johns, Lincolnshire (2009 onwards). The soil was previously sterilised by steam or Basamid (dazomet). 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). Antirrhinums were obtained as plug plants (from Florensis Cut Flowers) and transplanted through black polythene film at 64 plants/m² into trial plots about 3 m in length. Once established, most water was applied through lay-flat irrigation. Once in growth, plants received a weekly liquid feed, increasing to twice per week on vigorous crops later in the season. Support netting was provided. Preventative and curative crop protection products were applied as appropriate.

As part of the post-harvest quality assessment, simulated grower, transport, depot and retail phases were undertaken first (taking about five days in all), followed by the actual vase-life test under simulated consumer conditions.

Commercial evaluation of traditional snapdragons

Since little was known of the production economics of antirrhinums, a substantial (4,000 m²) evaluation was carried out on a commercial nursery in 2007. Many cultivars from the 'Axiom', 'Opus' and 'Potomac' series were grown, transplanting plug plants through carrot film to slightly raised beds profiled to allow water to run-off (snapdragons are sensitive to waterlogging).

Cultivars of the 'Potomac' series produced the best and most consistent flower stems, with 'Apple Blossom' the most attractive cultivar and some others - 'Deep Orange', 'Early White', 'Ivory White', 'Plum

Blossom', 'Royal' and 'Yellow' – being noteworthy. Stems were cropped with five open florets and a 15 cm flower spike length, the specification required a stem length of 60 cm and weight of 40 g.

Overall, only 74% of the stems achieved this specification, far fewer than some other crops planted at the same density, where 90 to 95% could be expected to do so. The specified stem weight was difficult to achieve and 30-35 g would have been more realistic.

Contrary to the requirements of antirrhinums, the weather was very wet around planting time, and there is no doubt that this adversely affected performance. In tunnels the warm weather conditions also led to soft growth, and stem quality was no better than outside.

The costs per thousand plants were about £10 to plant, £10 to crop and £20 to market. With a return of about £0.20 per stem this operation proved uneconomic. In the Netherlands snapdragons are grown on a large-scale outside, with lower costs and better returns from the auction.

Demonstrations of peloric antirrhinums

In 2009 the CFC was able to demonstrate two coded new lines of peloric antirrhinums. Plug plants were transplanted in week 28 into outdoor and tunnel plots. Both lines grew well in both situations, and their attractive form and vigorous growth were well received by growers, packers and retailers.

In 2010 an early crop of 'Ivory White', 'Red' and 'Yellow' peloric antirrhinums was grown in tunnels. Plugs transplanted in week 14 cropped around week 22, with stems averaging 66 cm in length and 53 g in weight. There was a second flush of flowers around week 28, shorter and lighter than those of the main flush but still marketable with stems averaging 55 cm in length and 49 g in weight. Substantial numbers of stems were supplied to buyers and account managers, involving at least six major packers, and product assessments were undertaken in both the UK and the Netherlands.



3. New peloric antirrhinum lines grown in trials at the CFC in 2009



4. 'Ivory White', 'Red' and 'Yellow' peloric antirrhinums grown in trials at the CFC in 2010



5. Second flush from an early crop of peloric antirrhinums

In 2011 plug plants of 'Ivory White' and 'Yellow' peloric and 'Trumpet Pink' were transplanted into beds in a tunnel in week 17, later than in 2010, producing a first flush in week 25. Stem weights and flower spike lengths of the varieties varied considerably, though all were satisfactory. 'Ivory White' and 'Yellow' peloric gave stems of around 50 g when trimmed to 60 cm, with spike lengths of 25 and 20 cm, respectively. 'Trumpet Pink' was lighter in weight (36 g trimmed) but had longer flower spikes (30 cm). The second flush produced many more stems but these were lighter than the previous year at just under 30 g (trimmed), presumably because of the later planting. These trials indicated that peloric varieties could be planted as early as week 14 or as late as week 26.

Plug plants of 'Trumpet Tangerine' also became available for testing in 2011. In week 27 they were transplanted into beds in both 'Haygrove' and 'Pro-Tech' tunnels, the latter giving more protection due to its end wind-breaks. Despite late planting, stem length was well in excess of 60 cm, trimmed weight was about 50 g, and spike length was 20-25 cm, about the same as the best from the earlier planting. As a consequence of the late planting there was insufficient time for a second flush of flowers.

Trials of 'Apollo', 'Potomac' and 'Trumpet' series

In 2012, plug plants of the traditional cultivars 'Potomac Rose' and 'Potomac White' were planted in a tunnel in week 22. Flowers were ready for cropping in weeks 34 to 35. The stems were tall (about 120 cm before trimming) with long spikes (25-30 cm) and trimmed (70 cm) weights of 55-60 g, similar to those from the peloric plantings of the previous year and a considerable improvement over the first antirrhinum evaluation of 2007.

Plug plants of 'Trumpet Tangerine' and cultivars of another peloric series, 'Apollo' (two coded new lines and 'Cinnamon', 'Ivory', 'Ivory', 'Purple' and 'Yellow') were also planted in a tunnel in week 28 in the same year. They were ready for cropping in week 34 and were left in situ for the CFC Open Day (week 37) when it was clear to participants that stem length, spike length and numbers of flowers far exceeded any minimum supermarket specification.

Vase-life testing

In 2007 stems of traditional cultivars from the 'Axiom', 'Opus' and 'Potomac' series, grown under glass or outside, were picked at a standard stage of development for testing, using 'Chrysal CVBN' pre-treatment solution. All exceeded their guaranteed five day vase-life, with between six ('Opus Red') and 10 days ('Potomac Apple Blossom'). 'Opus Red' exhibited low water uptake and a low flower quality score. In further tests, stems performed no better than controls in plain water when either placed in a range of pre-treatment solutions after picking or when a range of different cut flower foods was used in the vase.

Samples of peloric antirrhinums (including the 'Trumpet' series) were also tested. In 2010 stems of three peloric cultivars were picked at an earlier-than-usual stage, achieving a vase-life of up to 15 days. In 2011, samples of 'Ivory White' and 'Yellow' peloric cultivars and 'Trumpet Pink' were tested following picking at a standard stage. This time a vase-life of only 10 days was achieved.



6. Late cropping stage for peloric antirrhinums

Overall the vase-life of antirrhinums, traditional and peloric, was adequate though not spectacular. Despite suggestions that peloric snapdragons should be picked at a later-than-usual stage of development so their unusual form is evident while on retail display, the vase-life of one batch was decreased substantially by later (rather than standard) picking. There was also no evidence in these trials of varietal selection for improved vase-life, and, contrary to some reports in the literature, using different preservative solutions and flower foods did not appear to give any improvement in vase-life.

Conclusions from the trial work

- Successful crops were obtained from plantings as early as week 14 or as late as week 26, with the first flush some eight weeks after transplanting. The earlier planted crops gave a

useful second flush of somewhat lighter and shorter stems, some still meeting the specification. Growing traditional and peloric antirrhinum cultivars under tunnels should give crops over about a three month period during the summer. It should be possible to meet specifications, but that demands somewhat higher returns.

- Tunnel-grown 'Apollo', 'Potomac' and 'Trumpet' cultivars met the specification for stem weights (trimmed to 60 cm) of 50 g or more and spike lengths of 20-30 cm.
- A new range of peloric antirrhinums, the 'Trumpet' series, was highly appreciated by the industry for its attractive, unusual blooms and strong stature. Problems over marketing the blooms too early (before the novel form can be appreciated) suggested that picking should be at a more advanced stage than for traditional antirrhinums, but this may not be possible because of the adequate, though not long, vase-life; however, a longer vase-life was obtained and appearance was satisfactory when the stems were cropped earlier.
- There is a need to seek a further improvement in vase-life through pre-treatment and other preservative solutions and flower foods, to give a safety margin of post-harvest life.
- At present there are only pink and tangerine flower colours available in the 'Trumpet' series, though other peloric series are available to extend the colour range: 'Apollo' has cinnamon, ivory, purple and yellow, while 'Chantilly' has bronze, deep orange, light pink, pink, light salmon, cream-yellow, yellow and white coloured 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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