Sunflowers (*Helianthus annuus* cultivars) as a field- and tunnel-grown cut flower crop

Grower summary

- Since the 1990s sunflowers, mainly cultivars of the annual sunflower *Helianthus annuus*, have been a cut flower with wide appeal. They are grown as field crops or under glass, so they may be a suitable crop for growing in tunnels
- Over the same period, plant breeders have hugely increased the variety of ornamental sunflowers available, not only making them more versatile with a wider range of colours, but also producing more compact cultivars that might be better as cut flowers
- Sunflower seeds are large, easy to germinate, and can be sown in cells for transplanting or direct-drilled in the field. The planting density used varies greatly, depending on the number of side-shoots, germination rate and size of cut flowers required. At the Cut Flower Centre (CFC), a planting density of 36/m^2 proved satisfactory. Sunflowers prefer full light, good air movement, ample water, well-drained soils of pH 6.5–7.5 and high fertility
- Sunflowers may be attacked by a range of pests and fungal diseases, often requiring the application of preventative and curative plant protection products. Currently, petal-spotting is a concern and its cause is being investigated
- A useful compromise on the picking stage is to pick when the ray florets are between half and fully expanded, usually when the petals are perpendicular to the flower head. Using a suitable post-harvest treatment increases vase life, while subsequent use of a conditioner assists the opening of the flowers when they have been picked at a relatively immature stage
- As a result of their size and weight, cropping and handling sunflowers is labour-intensive and requires more space to work in than most other cut flower subjects
- Cultivars were evaluated for outdoor growing in 2010 and 2011; the results demonstrated their susceptibility to adverse weather. In 2010, drilling was followed by periods of dry, then wet and windy weather, though plants from an early sowing yielded stems of acceptable quality. 'Premium Lemon' and 'Premium Light Yellow' were compact, having stem lengths of 45 and 48cm, while 'Galilee Adami', 'Sunrich Orange' and 'Zohar Yellow' were longer (109–151cm). In two later sowings, germination was poor and the product was unmarketable due to adverse weather
- In 2011, the weather was moderate and two sowing dates produced marketable flowers.

Figure 1. A range of field-grown sunflower cultivars on trial at the Cut Flower Centre

'Happy Face' was the most compact cultivar (average length 90cm), 'Dafna', 'Stellar Sun', 'Jua Maya', 'KB 105', 'KB 135' and 'Early Sunrise' were progressively longer (113–140cm) and 'Galilee Orange' was tallest (158cm). Stem lengths increased in the later sowing. Percentage seed germination varied from 38 to 100 per cent, indicating that work is needed to improve seed quality

- **In 2012 and 2013, cultivars were evaluated in the field and in a tunnel. The summer of 2012 was wet, and although 'Vincent's Choice', 'Vincent's Fresh' and 'VV 10-4' produced good-quality stems in the tunnel, germination was poor in the field, and flower quality was unsatisfactory due to damage by wind and rain. In the tunnel, average stem lengths were 190, 160 and 150cm respectively, although 'VV 10-4' was lighter in weight, with a smaller flower head. Grown outdoors, all cultivars developed to only 50–75 per cent of their length under protection, advantageous were it not for the deleterious effects of the wet weather**
- **In 2013, 'Galilee Adami', 'Galilee Miracle', 'Galilee Orange', 'Helios Flame', 'Tanya', 'Tavor Flash Bicolour', 'Tavor Joy' and 'Tavor Lemon' and five numbered lines were drilled into beds outdoors (two sowings) and in a tunnel. When field-grown, average stem lengths across the two drilling dates varied from 90cm ('Galilee Miracle') to 162cm ('Galilee Adami'); other compact cultivars were 'Tanya' (also small-headed) and 'Tavor Lemon', both around 100cm. Grown in the tunnel, the stems were substantially longer, from 24 per cent more ('Tavor Flash Bicolour') to 81 per cent more ('Galilee Miracle') than outdoor crops**
- **With the superior results obtained under protection, a further trial in 2014 was undertaken only in a tunnel. 'Galilee Orange', 'Happy Face', 'Helios Flame', 'Lemon Party', 'Rio Carnival', 'Solar Flash', 'Stellar Sun', 'Superted', 'Tall Timber', 'Tanya' and 'Tavor Flash', and numbered lines 'PV 174', 'PV 197' and 'PV 199', were sown in beds in weeks 27 and 30. For most cultivars, germination rates were high and growth rapid. 'Carnival' and 'Solar Flash' were considered too short to reliably reach a 65cm-long specification in any weather**
- **Using a growth regulator on standard cultivars might be an alternative to growing compact cultivars. However, two applications of 'B-Nine SG' at a standard rate to 'Sunrich Orange' did not reduce stem extension**
- **Standard vase life (VL) testing was carried out on five field-grown cultivars in 2011 and five cultivars grown in a tunnel in 2014. After the five-day simulation of the grower, transport, storage and retail store phases, VL in the 2011 tests averaged 11 days (with 'Dafna' having an exceptional VL of 15 days) and seven days in the 2014 tests**
- **The results suggest that a high-quality cut flower crop could be obtained by growing available cultivars in tunnels rather than outdoors, mainly through protection from adverse weather. More compact cultivars are desirable, to reduce labour and space requirements. Growing sunflowers outdoors can produce more compact plants and good crops in some years, but the UK climate can lead to weather damage, especially in the autumn, and in some years severe losses have been experienced**

Introduction

In its native North America, the annual sunflower, *Helianthus annuus*, has a long history as a source of medicine, food, oil and dye. Unlike other cut flowers, it is first and foremost an oilseed crop on the world stage. Yet in the 1990s, sunflowers as cut flowers became a fashion icon, and have continued to be popular to the present time, helped by the great advantages of being prolific and relatively easy to grow. In the UK, commercial cut flower sunflowers occupy some 400ha, with a farmgate value in excess of £7m (2016 estimate). Plant breeders in Europe, Japan and the USA have produced many ornamental cultivars of *H. annuus*, including single stem ('grandiflora') and branching ('multiflora') types, standard and compact cultivars, and fully double flowers. Since the species may reach a height up to 5.0m, a cultivar 1.0–1.5m in height might be classed as 'compact'. As well as the classic yellow, the ray florets can be bright orange, bronze, cream, lemon, pale green or pinkish bronze, or bicoloured, with the disc florets brown to black, some with green centres. Recent cultivars show greater uniformity, vigour and keeping qualities, some are pollenless, and other traits incorporated include a day-neutral response for flower initiation and the ability to thrive in cooler climates. In addition to their role as cut flowers, they are grown as flowering pot plants and for dried and dyed flowers.

As cut flowers, sunflowers are generally grown in the field or as glasshouse crops; in the field, they are susceptible to adverse weather (high rainfall, humidity or wind), while growing them under glass is costly but will generally result in a better product. With the increased availability of 'Spanish' and related types of polythene tunnels in the UK, sunflowers could be grown as a seasonal tunnel crop, avoiding the rigours of growing in the field and the expense of glasshouse growing, while still producing a high-quality crop. The trials described later in this information sheet are largely concerned with developing the tunnel-grown sunflower crop and identifying suitable cultivars.

Helianthus species are native to North and Central America, Peru and Chile, growing in dry woodland and prairies but also in damp, swampy habitats. *H. annuus* and many others are classed as fully hardy in the UK, while others are frost hardy. *H. annuus* has provided the bulk of ornamental sunflower cultivars, while other species are used in horticulture to a small extent.

H. debilis (also called *H. cucumerifolius*) is a heavily-branched annual that has also been used to breed improved ornamental cultivars. *H. decapetalus*, the thin-leaved sunflower, is smaller, multi-flowered and has produced some good cut flower cultivars.

Other, perennial, sunflower species have been used as niche cut flowers or as garden plants; they include *H. maximiliani,* tall (3.0m), late flowering and useful to extend the season, and *H. augustifolius* (swamp sunflower) and *H. salicifolius* (willow-leaved sunflower), both tall (2.0m) and branching, with many small, yellow, daisy-like flowers.

Contact with sunflower foliage may cause skin allergies, so appropriate precautions should be considered. Some perennial sunflowers are potentially invasive. The remainder of this leaflet concentrates on *H. annuus* cultivars grown as cut flowers.

Cultural requirements and production methods

Cut Flower Centre (CFC) trials could not cover all aspects of production, so the sunflower trials concentrated on two topics of interest to growers: evaluating new cut flower cultivars and developing cut flower production in tunnels.

The information in this particular section deals with other areas of sunflower husbandry, and was compiled from textbooks, research findings, web-based information and the catalogues and websites of seed and young plant suppliers, and is given for guidance only.

The aim was to provide a consensus of key aspects of commercial cut flower growing under glass and in the field, and how this knowledge could be adopted for a tunnel-grown crop.

Cultivars

Despite the wide range of colours and heights available in modern cut flower cultivars, the traditional, large, yellow sunflower remains much in demand. A wide number of cultivars is illustrated in this factsheet; images and further details are available in the catalogues and on the websites of seed and young plant suppliers.

Scheduling and growing systems

Under glass and favourable climates, sunflowers can be grown over a long season. In the UK, large areas are grown in the field, where final quality is very dependent on the weather, with rain, high humidities and wind the greatest problems. Under suitable conditions outdoors, sunflowers can be grown between the late-spring and early-winter frosts. They can be sown or drilled sequentially every one to four weeks to maintain continuity of supply; with later planting dates, stem length and time to picking are both decreased. If transplanting seedlings, scheduling should take account of the need to transplant them promptly once ready, before they become too tall; holding them for more than three weeks leads to quality issues.

Propagation

Cultivars of *H. annuus* (and of other annual sunflowers) are produced from the large seeds (25–65/g) that germinate rapidly and easily. They are direct-drilled or, for transplanting, sown in plugs or small pots. In a glasshouse at 21–24°C, germination should occur in two to seven days, allowing transplanting at the two true-leaf stage two to four weeks later. Short-day cultivars intended for growing under natural short days may need to be propagated under long days if they are to achieve sufficient height.

Figure 2. Standard and compact cultivars from the 2014 CFC trials

Sowing or transplanting

The sunflower is highly adaptable, but prefers full light, good air movement, well-drained soils of pH 6.5–7.5 and high soil fertility. In the UK, sunflowers for field growing are usually direct-drilled 4–5cm deep, though elsewhere they may be transplanted as seedlings from plugs.

Most early field plantings are grown under fleece for protection from frost (and birds). Otherwise, sowing should be delayed until the danger of frosts has passed (ideally when the soil temperature is at least 10°C). Growing in tunnels or unheated glass allows much earlier planting.

The recommended inter-plant spacings range widely, between 15 and 60cm, more commonly between 20 and 30cm. The wider spacings are used for producing larger or branching cultivars, or where plants are to be pinched, and the closer spacings for smaller or non-branching cultivars, or for a single harvest of single stems.

Closer plantings reduce the likelihood of branching, and vice versa. Even closer spacings (5–10cm apart) have been recommended where small heads are required, though denser planting encourages disease. Direct-drilling in the field is reported to give thicker stems and larger flower heads than transplanting at the same spacing.

Glasshouse crops are usually grown in beds, but large pots or bulb crates have been used as alternatives. Recommended between-plant spacings vary widely, including between 5×5cm and 15×15cm, 15×23cm, or up to 50×50cm for branching cultivars. In the USA, one alternative is growing a quick crop in bedding plant packs. Using a small volume of growing medium limits plant size and decreases cropping time, but more frequent irrigation is needed.

Growing conditions

In practice, sunflowers may be grown under natural day lengths throughout. The day length requirements of sunflowers are cultivar dependent, but most are facultative short-day plants, initiating flowers faster under short days but not dependent on short days for initiating flowers. The critical photoperiod is between 11 and 13 hours.

To obtain the tallest stems, they should be grown under long days for up to six weeks, then changed to short days (12 hours or less). Regarding light intensity, sunflowers grow best under full sun. In periods of low light, supplementary lighting improves the quality of glasshouse sunflowers. Under glass, sunflowers may be grown into winter if the market price is favourable, but supplementary lighting may be required.

Responses to temperature are also dependent on the cultivar. One recommendation for glasshouse sunflowers is for a night temperature of 10–13°C and a day temperature of 18–21°C. Flowering occurs most rapidly at 22°C, regardless of day length (faster flowering in summer is a consequence of warmer temperatures, not longer day lengths). Growth and development of cut flower sunflowers is optimal at 18–24°C, slows below 17°C, and is delayed below 10–13°C.

There is also a 'DIF' (differential temperature) response exhibited by sunflowers: growing under cooler nights and warmer days results in longer stems.

For faster flowering, it may be better to wait for two or three weeks for natural temperatures to rise than to start too early; and for late flowering, note that lower natural temperatures will delay flowering.

Nutrition and irrigation

As a result of their large frame and extensive root system, sunflowers take up large amounts of water from a depth down to 15cm; an average sunflower in active growth takes up 0.4cm^3 of water per day. However, they must not be overwatered. Sunflowers grow best when not stressed.

Sunflowers also require relatively high nutrient levels. When field-grown, the soil should be well prepared and adequate nutrients should be added according to soil analysis. One recommendation is for adding 9.8–12.2g/m^2 nitrogen. Depending on soil type, rainfall, irrigation and leaching, additional nutrients will be required in many cases, about three times, once before planting, again before the plants are 2.5cm high and as the flower head is forming, as side-dressings (10:10:10 N:P:K) or as a complete soluble fertiliser (20:5:30 N:P:K), at 200ppm nitrogen.

Figure 3. Seedlings after direct-drilling (4 June, left) and the crop in the field (22 July, right), in the 2013 CFC trial

In cool springs, during which nutrient uptake may be limited, starter fertiliser planted with the seeds or in bands 5cm to the side and 5cm below the seeds helps produce vigorous seedlings. Germinating sunflower seeds are sensitive to high soluble salts applied in row with the seeds, and nitrogen and potassium applied in this way should be limited, though higher levels of phosphorus can be tolerated.

Seedlings under glass, once emerged, can be fed lightly with a liquid feed (100ppm nitrogen). During the plug phase, 150–200ppm nitrogen should be applied when the roots are established, and thereafter the crop can be fed either continuously with a 100–150ppm nitrogen feed, or once a week with 300ppm nitrogen. A liquid feed of 150ppm nitrogen, 15ppm phosphorus, 200ppm potassium, 4ppm calcium and 50ppm magnesium has been reported to work well.

Plant manipulation and support

Normally, the terminal flowers have the longest stems and highest quality, while laterals produce smaller but still marketable flowers. Good yields of laterals can be produced by growing naturally branching cultivars on a wide spacing; alternatively the plants can be pinched, optimally when they have four to six pairs of leaves or are 20–30cm high (pinching older plants may produce laterals that are too short to market). Multiflora cultivars are well suited to pinching, giving side shoots that are relatively long and flower heads of intermediate size. Pinching can delay picking by one to two weeks and having pinched and non-pinched areas will spread the harvest.

UK growers do not provide any support for field-grown sunflowers, while elsewhere support with stakes or strong netting is recommended. Protected crops are not normally supported, although some growers find a layer of mesh useful. Some newer cultivars may be stronger in the stem.

Figure 4. Netting support in a commercial crop of field-grown sunflowers in Israel

Treatment with gibberellic acid can hasten flower initiation, thereby slightly accelerating flowering, but this does not appear to have been developed into a practical treatment. Various growth regulators, including ‘B-Nine SG’ (daminozide), have been used successfully to produce more compact pot plants, and could possibly be used to make standard sunflower cultivars more manageable.

Pest, disease and weed control

Sunflowers are prone to many pests and diseases, and applications of plant protection products are likely to be needed. Aphids that damage sunflowers include *Trama troglodytes*, the Jerusalem artichoke root aphid, common on cultivated Compositae.

Some caterpillar and moth larvae cause general damage and defoliation, with some burrowing into the flower heads and distorting them. The rosy rustic moth, *Hydraecia micacea*, is a pest of various robust ornamentals, including sunflowers. Cutworms can also be very destructive to sunflowers, cutting stems at ground level or climbing stems to damage leaves and flowers.

The chrysanthemum leaf miner, *Chromatomyia syngenesiae*, attacks glasshouse Compositae, including sunflowers, mining leaves extensively. *Lygocoris pabulinus*, the common green capsid, attacks sunflowers, leaving the tips of new foliage speckled and tattered.

Pollen beetles, *Meligethes* species, are attracted to many crop plants but do little damage and are mainly a cosmetic problem. Other pests include thrips, two-spotted spider mites and slugs. Many of these pests have alternate hosts, including weeds, so general hygiene in production areas is important.

Golvinomyces (Erysiphe) cichoracearum and other powdery mildews can cause severe damage to sunflowers, appearing as small, white spots on the upper surface and spreading to the whole leaf. Downy mildew, *Plasmopara halstedii*, can be serious, with chlorosis on the upper leaf surface and a white spore mass on the lower surface. A number of leaf spots cause yellow, brown or black spotting of foliage and stems, including *Alternaria* species and *Septoria* species.

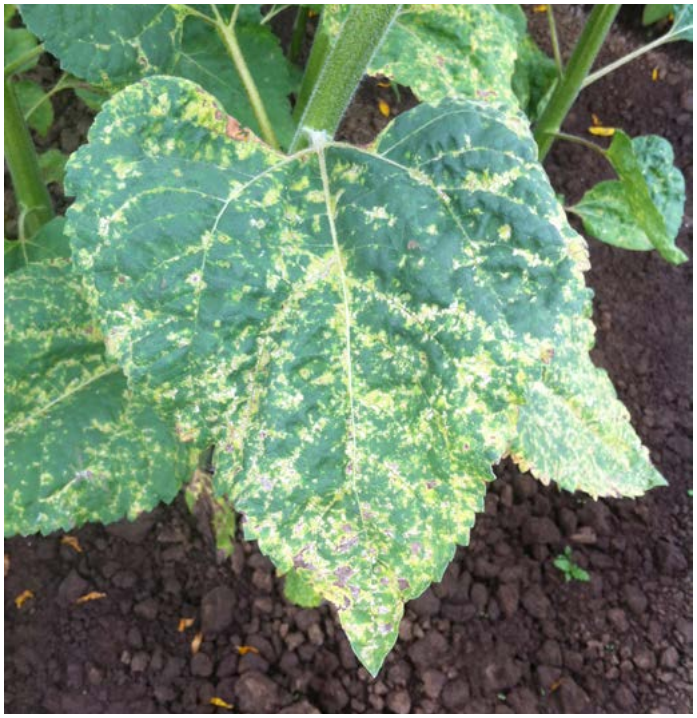

Figure 5. Septoria leaf spot disease on sunflower

Sclerotinia, mainly *S. sclerotiorum*, and *Sclerotium rolfsii*, result in stem and head rots with fungal mycelium evident on the surface. Rusts, primarily *Puccinia helianthi* and *Coleosporium helianthi*, are evident as the characteristic pustules on leaves and bracts. Verticillium wilt, caused by *Verticillium dahliae*, is more likely to show as an interveinal leaf mottling that leads to the formation of dark brown or black areas. *Phoma macdonaldii* leads to black lesions centered on the petioles and also on the head. *Macrophomina phaseolina*, or charcoal rot, causes silvery-grey lesions at the base of the plant when it is stressed, the lesions eventually encircling the stem. Grey mould, *Botrytis cinerea*, mainly causes a head rot in sunflowers, but can also give rise to petal and leaf spotting in cool, wet summers. Treatments include cultural practices, soil sterilisation and fungicide applications; disease resistance is likely to be introduced into oilseed varieties before ornamental ones.

Figure 6. Example of petal spotting (left side of ray florets) on a rejected sunflower stem

Sunflowers are susceptible to aster yellows, caused by a phytoplasma (mycoplasma). The symptoms are leaf chlorosis (affecting whole leaves or sectors of leaves), proliferation of secondary shoots and head abnormalities. The phytoplasma is spread by leafhoppers when feeding, and has a wide host range.

Some physiological disorders can occur. Floral deformities may occur, such as distortion of the flowers, or half-open or stunted flowers.

Some of this damage may be related to insects, so good pest control is important, though extremes of temperature during floral initiation have also been blamed. Anything that interferes with good root growth, such as dense clay soil or poor nutrient availability, can influence flower quality. Recently, in the UK, petal spotting has become an issue, and was reviewed in the 2016 annual report on AHDB Horticulture Project PO/BOF 002a. The spots or blemishes produced can become brown and necrotic, serious enough to make produce unsaleable; a study is under way.

In terms of weed control, ‘Stomp Aqua’ (pendimethalin, 2.9L/ha) is used as a pre-emergence herbicide applied after drilling. Although this herbicide does not control groundsel or mayweed effectively, sunflowers grow quickly and generally out-compete weeds once established. Alternative herbicides with different weed control spectra that can be used pre-crop emergence include ‘Dual Gold’ (s-metolachlor, 0.78L/ha applied in May only), ‘Flexidor 500’ (isoxaben, 0.5L/ha) and ‘Wing-P’ (dimethenamid-p and pendimethalin, 3.5L/ha). There is not normally a requirement for post-emergence herbicide treatments.

Picking, specifications and packing

The sheer bulk of the sunflower crop creates problems not usually encountered in cut flower crops. Additional space and labour are required for transport from the field to the packhouse, for storage and for packing. Although they are robust, sunflowers nevertheless need to be treated appropriately to avoid damage.

Any delay in harvesting can have a serious effect on vase life (VL) because of the speed with which sunflowers develop. Some recommendations state that sunflowers should be irrigated before picking, to counteract the rapid wilting that may occur, but this is very rarely practised in the UK. Recommended picking stages vary from cutting tight, when the ray florets are barely visible, to almost completely open. A useful compromise is to pick when the ray florets are between half and fully expanded, usually when the petals are perpendicular to the flower head. If picked too tight and stored cool, they may not open properly. Stems with blemishes or spotting on the flower heads are unlikely to be acceptable. The leaves should be removed, certainly any that would be below the waterline, and preferably all of them, not only because of the speed at which they deteriorate but also to save weight when transporting.

Figure 7. Examples of a very tight picking stage (left) and a more open stage (right), as used by different growers

Post-harvest care

After picking, the stems should be placed promptly into water containing a post-harvest treatment (such as 'Chrysal CVBN'), which assists water uptake. *H. annuus* is reportedly not sensitive to ethylene. Sunflowers can be cold-stored for around a week before marketing (figures quoted by various sources include 1–2°C for up to seven days, 2–5°C for seven to ten days, and 3–5°C for up to seven days), which may be extended with the use of an appropriate treatment. One report quoted a range of VL from five to 13 days across 33 cultivars, mostly greater than seven days.

UK crops can remain in water from the post-harvest treatment through to display in the store, when a conditioner (such as 'Chrysal Clear Professional 2 T-bag') can be used. However, if the flowers have been picked at an immature stage' the post-harvest treatment should be followed by use of a suitable conditioner (such as 'Chrysal Clear Professional 2 T-bag' or 'Chrysal Professional 3') to encourage opening. In the vase, the addition of a universal flower food is recommended. Other treatments mentioned in the literature, such as re-cutting and plunging into warm water or standing in water with a suitable wetter added, are not recommended.

Figure 8. Sunflower 'Sunrich Orange' at vase life day five following post-harvest treatment in water (top) or 'Chrysal CVBN' (bottom)

Summary of National Cut Flower Centre trials

Overview of the work at CFC

Sunflowers were grown on 1.0m-wide beds, either in the field or in 'Spanish'-type tunnels on a deep alluvial soil at Holbeach St Johns, Lincolnshire. The soil in the tunnels used for growing sunflowers was usually sterilised with steam in the previous winter (2013 was an exception). Fertiliser applications were carried out 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 production (indices of two for nitrogen, six for phosphorus, four for potassium and four for magnesium). Sunflower seeds were sown by hand into four row beds, with rows 35cm apart and seed 12.5cm apart in the rows in 2010 (giving 32 plants/m^2), but subsequently 10cm apart (36/m^2). After establishment, water was generally applied via lay-flat tubing and plants received a liquid feed approximately weekly. In tunnels, two layers of support net were provided. Preventative and curative crop protection products were applied as appropriate.

To assess post-harvest quality, stem samples were taken for standard vase life (VL) testing: simulated grower, transport, depot and retail phases were undertaken first (taking five days in total), followed by the VL test under simulated home conditions, during which stems were checked daily to assess the end of VL. The VL figures quoted are the number of days the flowers displayed acceptably in the vase, not the full period after picking.

Field-grown cultivar trials (2010 and 2011)

The sheer size of the typical sunflower means that harvesting and handling impose exceptional labour, space and waste disposal demands on a cut flower grower. If successfully adopted, more compact cultivars might provide a substantial reduction in such demands.

A selection of five cultivars was evaluated in 2010, including two new dwarf cultivars from the 'Premium' series. Seeds were sown by hand (as described above) on beds outdoors in weeks 24, 25 and 26. A spell of very dry weather, followed in turn by wet and windy conditions, resulted in poor germination and establishment, particularly in the later sowings. Although 'Premium Lemon' and 'Premium Light Yellow' were compact, with average stem lengths for the early sowing of 45 and 48cm respectively, flower quality in each case was generally poor. The mean stem lengths of 'Zohar Yellow', 'Sunrich Orange' and 'Galilee Adami' from the early sowing were 109, 129 and 151cm, and flower quality was satisfactory. Despite the disruptive effects of the weather, the compact 'Premium' cultivars would appear to have promise under better conditions.

In 2011, a further eight cultivars were evaluated, with sowing occurring in weeks 19 and 22. With more moderate weather, establishment, growth and quality were satisfactory (Table 1). The percentage seed germination varied from 38 to 100, the average of 74 per cent indicating that further work is needed by breeders to ensure more uniform seed quality. 'Happy Face' was the most compact cultivar, averaging around 90cm in height and among the others, 'Dafna', 'Jua Maya' and 'Stellar Sun' were relatively short (averages of less than 125cm),

while ‘Galilee Orange’ was the tallest at around 160cm. For most of these cultivars, stem lengths were greater from the later sowing, but this was not always accompanied by increased stem weight, with no obvious relationship apparent between the two; thus the compact ‘Happy Face’ had a relatively high stem weight. Flower head diameter varied between 14 and 19cm but was not consistent across sowing dates. Cropping dates varied from 10 to 18 August across the week 19 sowings, and from 18 August to 2 September for the week 22 sowings. The earlier sown ‘Early Sunrise’, ‘Jua Maya’ and ‘Stellar Sun’ were faster to crop than the other varieties, whereas cropping dates for the later sowing were more uniform (although ‘Stellar Sun’ was again quick to crop).

Table 1. Field-grown sunflower cultivar germination and flowering information, 2011 CFC trial

Sowing week	Cultivar or experimental line	Germination (%)	Peak cropping date	Stem length (cm)	Stem weight (g)	Flower head diameter (cm)
19	‘Dafna’	100	01 Sep	113	366	17
	‘Early Sunrise’	67	10 Aug	127	398	15
	‘Galilee Orange’	81	17 Aug	150	574	18
	‘Happy Face’	38	17 Aug	87	688	19
	‘Jua Maya’	64	10 Aug	126	430	15
	‘KB 105’	69	18 Aug	118	347	14
	‘KB 135’	42	18 Aug	112	511	17
	‘Stellar Sun’	42	10 Aug	110	728	18
22	‘Dafna’	86	01 Sep	112	367	16
	‘Early Sunrise’	72	02 Sep	153	482	19
	‘Galilee Orange’	100	02 Sep	165	526	19
	‘Happy Face’	88	30 Aug	92	392	16
	‘Jua Maya’	93	30 Aug	123	209	15
	‘KB 105’	81	02 Sep	153	653	19
	‘KB 135’	97	02 Sep	162	676	19
	‘Stellar Sun’	63	18 Aug	127	509	15

Figure 9. Field-grown cultivars from the 2011 CFC trial (left to right, top and bottom): ‘Early Sunrise’, ‘Jua Maya’ and ‘Stellar Sun’

Field- and tunnel-grown cultivar trials (2012 and 2013)

The previous trials showed that quality sunflower production can be difficult in field-grown crops.

Growing in 'Spanish'-type tunnels could be useful for protection from adverse weather, providing an economical alternative to glasshouse production and enabling extension of the cropping season.

In 2012, three novel cultivars, 'Vincent's Choice', 'Vincent's Fresh' and a numbered line, 'VV 10-4', were direct-drilled as before, both in the field (week 23) and in a tunnel (week 31).

In the tunnel, germination and establishment were satisfactory. 'Vincent's Choice' averaged 1.9m tall stems weighing 200g (after trimming to 65cm) with a flower diameter of nearly 18cm, while 'Vincent's Fresh' was shorter and lighter (1.6m and 150g), with a similar head size. 'VV 10-4' was only a little shorter than 'Vincent's Fresh' (1.5m), but had much lighter stems (110g) and smaller heads (12cm) and therefore showed potential as a more cost-effective product.

In common with many commercial crops in 2012, the wet weather was not favourable to the field-grown plots, with poor germination and damage to the petals from wind and rain. The average stem lengths outdoors were between 50 and 75 per cent of the lengths obtained in the tunnel: 1.1m for 'Vincent's Choice', 1.2m for 'Vincent's Fresh' and 0.75m for 'VV 10-4'.

Feedback suggested that 'VV 10-4' has the potential as a compact cultivar with a bright but not too large flower head, a good VL and the advantage, compared with standard sunflowers, of manageability.

In a more comprehensive trial undertaken in 2013, cultivars 'Galilee Adami', 'Galilee Miracle', 'Galilee Orange', 'Helios Flame', 'Tanya', 'Tavor Flash Bicolour', 'Tavor Joy' and 'Tavor Lemon' and five numbered lines ('CF 100', '639', '652' and '654', and 'KB 198') were direct-drilled to outdoor beds (weeks 15 and 23) and in a tunnel (week 30).

In the field, despite dry weather, some cultivars started to produce marketable stems from mid-June onwards, with the second planting coming into flower in time for the CFC Open Day in early August when growers could make their own judgements.

In the field, average stem lengths across the two drilling dates varied from 90cm for 'Galilee Miracle' to 162cm for 'Galilee Adami'; other compact cultivars were 'Tanya' (also small-headed) and 'Tavor Lemon', both around 100cm long (Table 2).

For sunflowers grown in the tunnel (drilled week 30), the stems were substantially longer, from 24 per cent longer ('Tavor Flash Bicolour') to 81 per cent longer ('Galilee Miracle') than those grown outdoors.

Table 2. Field- and tunnel-grown sunflower cultivar stem lengths and flower dimensions, 2013 CFC trial

Cultivar	Field, planting week 15		Field, planting week 23		Tunnel, planting week 30	
	Overall stem length (cm)	Flower head diam. (cm)	Overall stem length (cm)	Flower head diam. (cm)	Overall stem length (cm)	Flower head diam. (cm)
'CF 100'	144	8	134	8	n/a	n/a
'CF 639'	145	7	148	7	231	6
'CF 652'	142	8	161	8	225	7
'CF 654'	150	7	148	6	224	6
'Galilee Adami'	143	7	176	8	207	6
'Galilee Miracle'	85	7	95	7	163	6
'Galilee Orange'	120	7	153	7	n/a	n/a
'Helios Flame'	147	7	124	6	189	5
'KB 198'	146	7	146	7	216	6
'Tanya'	97	3	102	4	n/a	n/a
'Tavor Flash Bicolour'	147	6	150	7	185	6
'Tavor Joy'	102	8	132	8	199	6
'Tavor Lemon'	101	6	101	7	176	7

n/a = not available

Further tunnel-grown cultivar trials (2014)

With the superior results obtained under protection, a further trial in 2014 was grown only in a tunnel. Cultivars ‘Galilee Orange’, ‘Happy Face’, ‘Helios Flame’, ‘Lemon Party’, ‘Rio Carnival’, ‘Solar Flash’, ‘Stellar Sun’, ‘Superted’, ‘Tall Timber’, ‘Tanya’ and ‘Tavor Flash’, and numbered lines ‘PV 174’, ‘PV 197’ and ‘PV 199’, were sown in beds in weeks 27 and 30. For most cultivars, germination rates were high and growth rapid. ‘Carnival’ and ‘Solar Flash’ were considered too short to reliably reach a 65cm-long specification in any weather. Stems of the earlier sowing were picked in weeks 35–37 and, for the later sowing, in weeks 39–40.

Growth regulator trial (2011)

Using a plant growth regulator on standard sunflower cultivars might be an economical option to growing dwarf cultivars. ‘B-Nine SG’ (daminozide) was chosen for testing because it is already routinely used on chrysanthemum which, like sunflower, is a member of the Compositae. As an addition to the 2011 cultivar trial (and using the same methods), the regulator was applied to plots of ‘Sunrich Orange’ that had been sown in weeks 19, 22 and 26 in outdoor beds, with control plots being left untreated. The regulator was applied as a foliar spray to ‘run-off’ at a rate of 6g product/L (5,100ppm active ingredient) in week 32 and again in week 33 (when the plants were about 0.5m tall). However, it was obvious that the regulator application did not reduce plant height.

Vase life testing (2011 and 2014)

Samples of stems from the 2011 and 2014 trials were taken for standard vase life (VL) testing. In 2011, stems of ‘Dafna’, 'Early Sunrise', ‘Galilee Orange’, ’Happy Face’ and ‘KB105’ were sampled in week 35. After eight days in the vase (following the five days of preliminary treatments), ‘Galilee Orange’ stems were beginning to weaken and petal drop was starting in ‘Early Sunrise’.

With the exception of ‘Dafna’, VL was terminated after 11 days in the vase; ‘Dafna’ was longer-lasting and terminated after a total of 15 days in the vase. Although all cultivars tested attained the usual number of ‘guaranteed’ days, the outstanding result was the quality and long VL shown by ‘Dafna’.

In 2014, stems of ‘Helios Flame’, ‘Tavor Flash’ and three numbered lines were subjected to standard VL testing in week 36. Following the five days of preliminary treatments, all the cultivars had a consistent average VL of seven days, thereby just attaining the usual number of ‘guaranteed’ VL days.

Some stems started to bend on VL day three (‘Helios Flame’) or by days five and seven (the numbered lines). Tipping of the petals was slight from day four with ‘Helios Flame’ and ‘PV 197’, and more progressive from day three with ‘Tavor Flash’. Some flower heads of ‘PV 197’ and ‘PV 199’ were breaking down by day seven.

Figure 10. Cultivars from the 2014 CFC trial: (top row, left to right); ‘Helios Flame’, ‘Lemon Party’, ‘Superted’ and ‘Tanya’; (bottom row, left to right) ‘Tavor Flash’ and the numbered lines ‘PV 174’, ‘PV 197’ and ‘PV 199’

Conclusions from the trial work

- Although sunflowers for cutting are grown in the field on a large scale in the UK, often with high product quality, the flowers can be spoilt by adverse weather, which leads to physical and pathological damage
- In trials in tunnels at the CFC, many cultivars of sunflower produced high-quality cut flowers comparable to those grown under glass, although of course their growing season is limited to between late spring and early winter frosts. Growing in tunnels means the plants are protected from the weather without the costs associated with glasshouse production
- Compared with field-grown crops, tunnel-grown sunflowers are taller, so growing in tunnels does not contribute to any reduction in the bulk of the crop, which is desirable to reduce its heavy demands for labour, storage and waste disposal
- The trials identified some relatively compact cultivars that would be suitable for tunnel production, but there is still a need to test further compact cultivars to increase choice. In trials, using a growth regulator was ineffective in reducing stem extension
- The trials identified a need to improve seed quality; germination rates were poor in some stocks

Figure 11. Cultivars from the 2011 CFC vase life trial

Authors

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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 **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 AHDB Horticulture and Lincolnshire Fenlands LEADER+ support. 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.

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