THE 2009 CUT FLOWER TRIALS

H.C. Wien, Department of Horticulture, Cornell University, Ithaca, NY 14853

EXECUTIVE SUMMARY:

A cool and rainy growing season provided challenging conditions, especially in the field, but allowed high tunnel-grown crops to do well. The details are below.

Introduction, weather, general methods: (P. 4)

Sunflower Bud Elimination Experiments (P. 6) : To get rid of flower buds that arise when photoperiod-sensitive sunflower lines are grown in short days, we treated six varieties with long days in either week 2 or week 3 after emergence. For 'Sunrich Orange', 'Orange Glory' and 'Zohar', long days in week 2 nearly eliminated flower buds; for 'Premier Lemon', 'Premier Light Orange' and 'Big Smile', only three weeks of long days were effective. Given these varietal differences, growing daylength-neutral varieties that do not produce the secondary buds is the most practical solution.

Rudbeckia Photoperiod Light Gradient Trial (P. 9): By planting rudbeckia 'Indian Summer' at right angles to a source of long-day photoperiod lights in a light regime of short days, we determined that rudbeckia needs a light intensity of about 3 umoles.m^{-2}.sec^{-1} to sense the longer daylength. At lesser intensities, the plants have progressively shorter stems, until about 0.5 umoles, below which they grow like short-day treated plants.

Rudbeckia Photoperiod Lighting Study (P.11): Using the information from the gradient trial, we grew 2 varieties of rudbeckia in fall in the high tunnel, and provided long days using either a solar-powered landscape light with 6 LED's, or a 9 watt fluorescent bulb powered by the electric grid. Light intensity of the grid light was uniform and broad enough to stimulate stem extension; the solar lamp only illuminated one plant per plot and thus stems stayed short.

Godetia Transplant Study (P. 13): To check on the effect of crowding in the seedling tray on plant performance after transplanting, we repeated a 2008 trial with godetia. The results confirmed the previous findings. Delaying transplanting by 2 weeks past the optimum, especially in a 210-cell tray, drastically reduces final plant size. Even transplanting late from a 72-cell tray had some adverse effects. Godetia is very sensitive to seedling crowding.

Lisianthus Transplant Study (P.14): The effect of crowding in the seedling tray was also checked with lisianthus, in a repetition of a 2008 experiment. As found in the previous year, growing seedlings in 210 cell trays for two extra weeks past the optimum transplant date had no significant deleterious effect on plant performance, compared to prompt transplanting. In contrast to godetia, lisianthus is less sensitive to early crowding.

Larkspur Topping Trial (P. 15): Removing the apical meristem from three varieties at node 6 increased number of stems harvested by 42% and increased average stem length from 62 to 68 cm. First harvest date was delayed 5 days by the procedure.

Stock (Matthiola) Topping Trial (P. 17): Topping is not to be recommended for this species, which did not branch, even when the apical meristem is removed at an early stage. All four varieties reacted the same way to the treatment.

Stock Date of Planting Trial (P. 18): In a repeat of a 2008 experiment, four stock varieties were sown at three times starting on March 4, and at two week intervals, with transplanting beginning on April 14. Unlike the previous year, all varieties flowered fully in all plantings. Apparently, conditions were cool enough during the growing periods for the vernalization requirements for flowering to be satisfied.

Sunflower Daylength Screening Test (P. 19): Nine new sunflower varieties were tested for their sensitivity to long and short days in the first three weeks after emergence. Four were indifferent, four were strongly sensitive, flowering more than 2 weeks later after long day than short day treatments, and one was moderately sensitive, being delayed 9 days after long day treatment. Of the varieties tested, 'Procut Brilliance' and 'Buttercream' look promising in having attractive flowers and lack of daylength sensitivity.

High Tunnel Tulip Trial (P.22): We compared the performance of four varieties under three planting methods: planting directly in the ground, planting in bulb crates in artificial mix but burying the crates in the tunnel, or cold storing the planted crates at 40 F from November until March. Infrequent watering, and excessive temperatures in April caused most of the plants in the crates to fail to flower. Those soil-planted performed well, flowering about 3 weeks earlier than those growing in gardens outside. The experiment is being repeated in 2009-2010.

VARIETY TRIALS:

1. **Calendula (P. 24):** Among four varieties tested in a fall tunnel trial, 'Greenheart Orange' stood out because of its long, strong stems and an outer ring of orange petals and a fuzzy center of green. 'Maayan' was earliest in the trial, with long stems and dark-backed petals and dark center.
2. **Campanula (P. 26):** Five campanula 'Champion' lines were grown in both high tunnel and field in the spring. Plants in the tunnel gave 2.5 times the yield of stems, and produced main stems and branches that were 63% and 83% taller than in the field. Topping of one of the varieties had no yield effect in the tunnel, but was of benefit to in the field. Varietal differences were slight in both trials.
3. **Delphinium (P.28):** Of the five varieties tested in the field, 'Centurion White' and 'Magic Fountain Cherry Blossom' stood out with their vigor and maintenance of

plant stand through the season. The latter also produced an outstanding yield of 5 stems per plant.

4. **Dianthus (P. 30):** The two new varieties 'Fandango Purple Picotee' and 'Bouquet Rose Magic' did not produce the stem length desirable for cut flower production and thus can't be recommended for field culture.
5. **Eryngium (P. 30):** Of two perennial species that flower in the first year from seed, E. planum 'Blue Glitter' and 'White Glitter' are attractive with compact inflorescences and medium height. Since they take until August from a February sowing to come to flower, they need to be grown several years to be worthwhile.
6. **Gomphrena (P.33):** Six varieties were grown both in high tunnel and field. Again, high tunnel-grown plants were a week earlier, taller and more productive. 'Audray Pink' and 'Audray Purple Red' as well as the standard 'All Around Purple' produced attractive stems all season with good stem length.
7. **Lisianthus (P. 34):** The cold, rainy conditions were unfavorable for lisianthus production in the field this year, reducing yield to 2 stems per plant on average. In the high tunnel, four of the eight lines tested did well. 'Cinderella Lime' is a double of medium maturity, good stem length and producing 7 stems per plant. 'Borealis Apricot' is slightly later, less productive, but with attractive pink petal color. Two single lines, 'Magic Deep Blue' and 'Advantage Purple' were also productive. Although shorter in stem length, the early 'Echo Champagne' continues to impress with its productivity.
8. **Snapdragons (P. 37):** The parade of good snapdragon varieties continues. In our trials of six varieties in tunnel and field, we identified two reds and two whites worth another look. "Appeal Scarlet' produced bright red florets on spikes of medium maturity. 'Opus Bright Red' was later, but had taller stems with velvet dark red florets. 'Axiom White' is a standard snapdragon flower of medium maturity, while 'Trumpet Pearl' has open throat florets and excellent productivity.
9. **Zinnia (P. 39):** Six varieties were tested in an early summer planting in the field, and in a fall tunnel planting. The field-grown plants produced blooms all summer, so that average yields ranged from 6 to 9 stems. "Red Beauty' had attractive bright red flowers of good stem length; 'Benary Giant Wine' had larger uniform flowers but was less productive. In the high tunnel, 2 to 4 stems were produced, and the highlighted varieties again looked good.
10. **Panicum 'Frosted Explosion' (P. 41):** Atrractive, productive but weak-stemmed.

ACKNOWLEDGEMENTS: I gratefully thank my assistant Liza White, and her summer helpers Andrew Hoffman and Molly Futterman for their conscientious help and dedication. I am also grateful for seed donations for these trials from Fred C. Gloeckner, Johnny's Select Seeds, Harris Seed Co., Geo Seeds, Takii Seed Co. and the Association of Specialty Cut Flower Growers. The Research Foundation of ASCFG funded the work on the daylength response of Rudbeckia reported herein.

MATERIALS AND METHODS: The 2009 cut flower trials were conducted at the East Ithaca Gardens, both in the field and in the high tunnel. The soil type for both is an Arkport Sandy Loam. In the field, about 2 in. of compost was applied in late fall 2008 and worked in. In April 2009, 50 lbs of a 20-10-10 fertilizer was spread on the land, and worked in with a disk. Thereafter, beds were formed on 6 ft. centers, with bed dimensions of 5 in. height, and 40 in. width. The beds were covered with 1 mil black plastic mulch, after two trickle irrigation lines were positioned on each bed. Supplemental nitrogen in the form of calcium nitrate at the rate of 30 lbs N per acre was applied as needed to the beds, when plants growing showed slow growth and yellow leaves. Typically, this was only needed once for each crop.

Soil management in the high tunnels consisted of a primary tillage operation using a walk-behind rototiller, and applying the same amount of fertilizer as outside. Building up the beds and applying the trickle tape and black plastic mulch was done by hand. To minimize salt buildup, no compost was applied in the tunnel in 2008 or 2009.

Plants for the variety trials were started in greenhouses from seed in seedling trays in Redi-earth artificial soil mix, at recommended temperatures for the species. The time of sowing was adjusted to assume access to the tunnel in the third week of April, and outdoors a month later. Except where noted, spacing was a staggered grid of 4 rows, with 9 in. between plants and rows. There were usually 20 plants in each subplot, and 2 replications in both the tunnel and outdoor experiments.

Plots in the tunnel were irrigated weekly all season long and twice weekly during the warmest periods. Stems were harvested at the recommended maturity stage for the species, and stem lengths were determined for each stem. Repeated harvests were made as needed, often at weekly or greater frequency. No fungicide applications were made to plots in the field in 2009, but a severe attack of Japanese Beetle necessitated 3 applications of Spectracide to the zinnia field trial. In the high tunnel, we used only OMRI-approved methods of pest control in 2009. These included release of ladybird beetles on several occasions for aphid control from late August on, and two applications of Cease fungicide to the fall zinnia and calendula trials for control of powdery mildew and botrytis. Except for one shielded spray of glyphosate in the paths of the field planting area, the rest of the season weed control was done by hand.

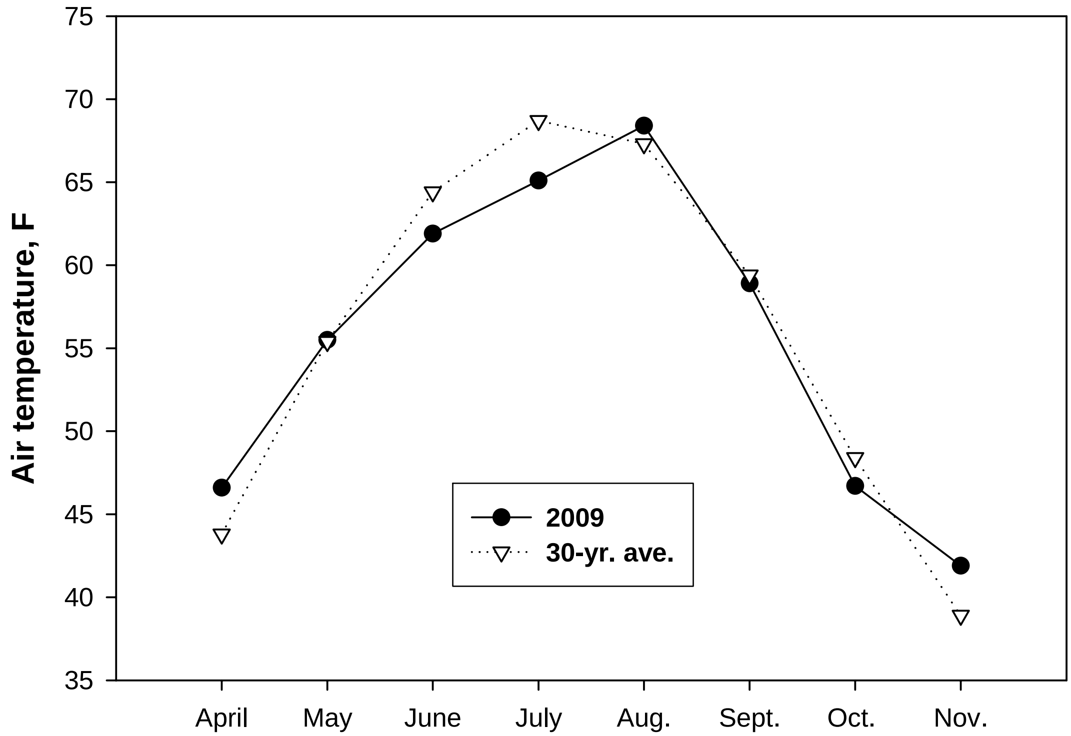

Fig. 1. Fig. 1. Air temperature during the 2009 growing season at Ithaca, compared to the 30-year average. Source: Northeast Regional Climate Center, Ithaca.

After an abnormally dry and warm April, the middle of the growing season in Ithaca was cooler and rainier than normal, before resuming more normal patterns during the late part of the growing period (Figs. 1, 2).

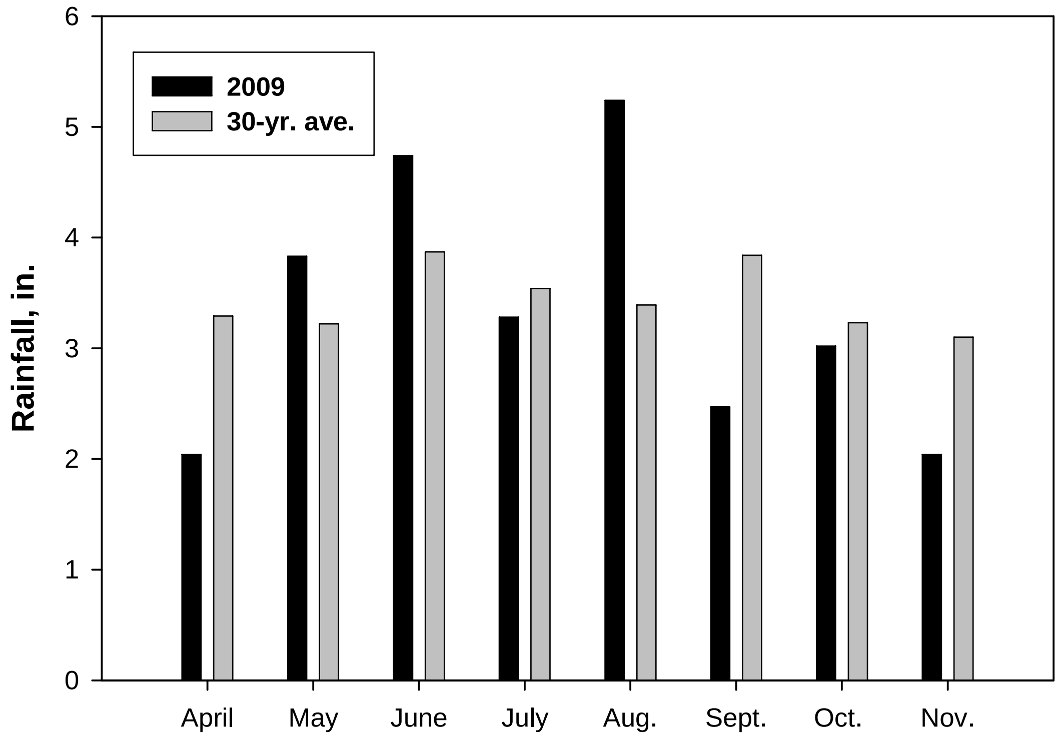

Fig. 2. Monthly rainfall totals in the 2009 growing season, compared to the 30-year average. Source: Northeast Regional Climate Center.

SUNFLOWER FLOWER BUD ELIMINATION EXPERIMENTS:

Some sunflower varieties are very sensitive to short days in the first three weeks after emergence, and produce a profusion of flower buds all along the stem. These detract from the appearance of the central flower, and make the early flowering under short days of these varieties a liability rather than an asset. Research in 2008 indicated that the number of these buds could be reduced with little decrease in earliness if plants were exposed to one week of long days in week 2 after emergence, with the other 2 weeks under short days. The present study was set up to test these results on more varieties.

Materials and Methods: Two experiments were conducted. In the first, seedlings of 6 varieties were either given short days (12 hrs daylength on a daylength-controlled bench in a greenhouse) or long days (16 hrs), or short-long-short, for the first 3 weeks after emergence. In the second experiment, the pattern was short-short-long. The plants were then transplanted to the field, where they were harvested at anthesis, to determine plant height, flower diameter, bud numbers on the upper 4 nodes, and dates of flowering. The varieties tested were Sunrich Orange, Orange Glory, Zohar, Big Smile, Premier Lemon and Premier Light Yellow. They were the same in both experiments. There were 24 seedlings per plot per variety, and the spacing in the field was 9 x 9 in. in 4-row beds mulched with black plastic. The experiments were sown on June 26 and July 20, respectively. Each had only a single replication.

Results and Discussion: Interrupting a three-week short day treatment with a week of long days in week 2 resulted in a reduction of axillary flower bud numbers in 'Sunrich Orange', as shown previously found (Table 1). 'Orange Glory' and 'Zohar' had similar reaction (data not shown) (Fig. 3). Premier Lemon, Premier Light Yellow and Big Smile, in contrast, showed little change with that treatment. Providing three long day weeks eliminated buds on all varieties except on 'Big Smile', on which they were reduced to 1.

Fig. 3. 'Orange Glory' sunflower treated with 3 weeks of short days after emergence (left) or alternating short and long day weeks (right) before transplanting to the field. Note fewer buds on upper nodes of plants on right.

Table 1. Effect of week-long photoperiod treatments beginning at emergence, on plant height, axillary flower bud numbers on the top four nodes of the stem, and date of first flowering for two sunflower varieties. After the three weeks of photoperiod treatments, plants were transplanted to the field, on July 21.

Variety	Treatment[z]	Plant height, cm	Bud no.	Flower date, DAS
Sunrich Orange	S-S-S	73	2.7	47
	S-L-S	95	1.1	54
	L-L-L	148	0	74
Premier Lemon	S-S-S	45	3.6	45
	S-L-S	55	3.2	47
	L-L-L	87	0	54

[z] S = 12 hr photoperiod; L = 16 hr photoperiod

In the second trial, sown in late July, the long day treatment was given in week 3, and was less effective than in the earlier-sown experiment (Table 2). Bud numbers were not affected by the treatment in 'Premier Lemon', and less reduced in 'Sunrich Orange'. The three week long-day treatment eliminated buds in 'Sunrich Orange', but did not affect bud numbers in 'Premier Lemon'. Again, 'Premier Light Orange' and 'Big Smile' acted similarly to 'Premier Lemon', and 'Orange Glory' and 'Zohar' had similar reaction to 'Sunrich Orange'. Overall, plants were shorter in all treatments in the second experiment, a characteristic common to late plantings of sunflower. The results indicate that excess bud numbers are difficult to eliminate by daylength treatments in the first three weeks after emergence, but there are cultivar differences in the response. The preferable solution would be to select for lack of daylength response in flowering, and absence of axillary buds, in an early-flowering variety.

Table 2. Effect of week-long photoperiod treatments beginning at emergence, on plant height, axillary flower bud numbers on the top four nodes of the stem, and date of first flowering for two sunflower varieties. After the three weeks of photoperiod treatments, plants were transplanted to the field, on Aug. 14.

Variety	Treatment[z]	Plant height, cm	Bud no.	Flower date, DAS
Sunrich Orange	S-S-S	69	2.6	53
	S-S-L	79	1.9	56
	L-L-L	104	0	67
Premier Lemon	S-S-S	36	3.2	41
	S-S-L	41	3.5	44
	L-L-L	61	3.0	50

[z] S = 12 hr photoperiod; L = 16 hr photoperiod

RUDBECKIA PHOTOPERIOD LIGHT GRADIENT TRIAL:

Rudbeckia hirta is a colorful perennial species that produces cut flowers with yellow to red-brown flowers. Unfortunately, under the short daylengths of late summer and fall, these plants fail to flower, or produce flowers with very short stems. Past work has shown that rudbeckia requires long days for flowering. If we know the light level required to trigger a long-day response in this species, could we install landscape lights in the production field to simulate long days? A preliminary experiment in the greenhouse determined the light levels needed to trigger a photoperiod response in 'Prairie Sun' rudbeckia, before using that information to screen the fixtures to use in fall plantings in high tunnels.

Materials and Methods: The light gradient was set up in the photoperiod-controlled bench in Guterman greenhouse. A row of six 3 in. diameter button lights, 9 watts each, spaced 8 in. apart, and 39 in. above the bench top, were connected to a timer that extended the photoperiod to 16 hrs. Rudbeckia plants (variety Prairie Sun) were sown in 72-cell trays on June 17, transplanted to 9 in. pots on July 23, and arranged with rims touching, in 4 rows down the bench, so that the light from the extended daylength got dimmer with distance. Beyond pot 15, a blackout curtain across the bench allowed another set of 16 pots to be grown under short day conditions (12 hrs). The light level was measured at each pot using a bar-type quantum sensor on Aug. 22, and plant heights were taken on Sept. 16, when plants close to the light source were flowering.

Results and Discussion: The light intensity of the extended daylength source varied from 4 umoles/m^2/sec close to the light bar, to 0.5 umoles/m^2/sec at the farthest pot. Plant height showed a similar pattern, so that a plot of light intensity of the daylength extension against plant height shows a positive relationship to a plateau of about 3 umoles/m^2/sec (Fig. 4).

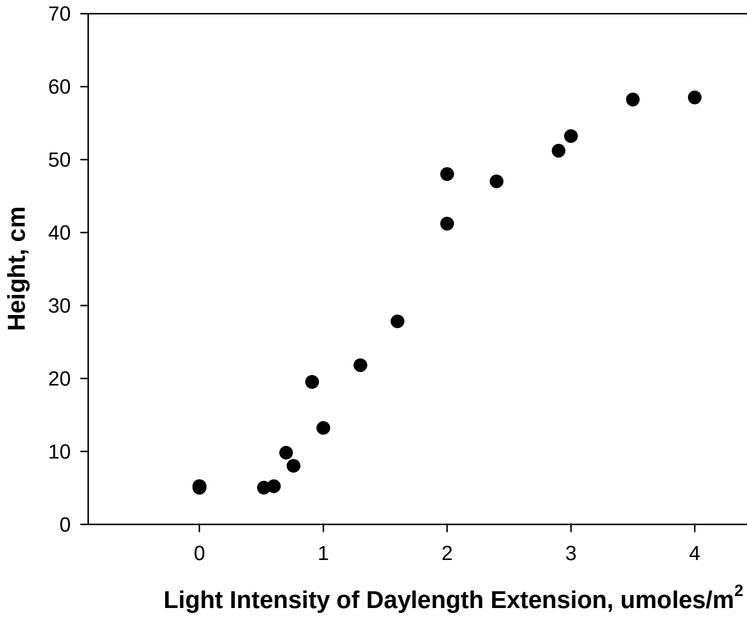

Fig. 4. The relationship of the light intensity (irradiance) of the daylength extension to the height of *Rudbeckia hirta* 'Prairie Sun' at flowering.

Fig. 5. Light gradient table in the greenhouse, showing the bar of button lights at the far end, and the reduced flowering of plants further from the extended light source.

Thus for optimum stem extension of Rudbeckia in late season trials, a light intensity of 3 umoles/m^2/sec needs to be achieved.

RUDBECKIA PHOTOPERIOD LIGHTING STUDY:

The light gradient study indicated that a relatively low irradiance level is sufficient to saturate the light requirement for the daylength response in rudbeckia (Fig. 3). If such light levels could be achieved using solar-powered landscape lights, these could be placed in plantings of this crop in fall to make it a desirable cut flower in autumn. Preliminary purchases of solar-powered landscape lights typically available at 'big box' stores failed to find any with sufficient light intensity. A more thorough search of solar lighting supply companies on the internet identified one that appeared to satisfy the requirements. To provide a full light control treatment, button lights like those used in the light gradient trial were used for another treatment.

Materials and Methods: The lighting study was planted in the high tunnel, using 'Prairie Sun' and 'Cherry Brandy' rudbeckia, and three lighting treatments: an unlit control, solar landscape lights with 6 LED's, and lights powered by mains current. The latter consisted of 9-watt circular fluorescent fixtures used in the gradient trial. These were controlled by a timer to extend daylength to 16 hrs. Lighting treatments were established on Aug. 20. The solar lights came on at dusk, and stayed on most of the night. Lights were spaced 6 ft. apart on 30 in. high stands, facing down. The trial was designed as a split plot experiment, with lighting treatments as the main plots, and the 2 varieties as subplots. Each subplot consisted of 18 plants, spaced 12 x 12 in. apart, with 3 rows per bed. There were 3 replications. To prevent light leakage to adjacent plots, a 3 ft. high black woven silt barrier cloth surrounded all subplots. Flowering stems were harvested at anthesis and stem length measured.

Results and Discussion: As the daylength became shorter in late summer, stem growth in the unlighted plants stayed short, whereas those exposed to 16 hr daylength in mains lights started to elongate normally. Plants under solar lights were intermediate in reaction (Table 3). By the end of the harvest season, stem length and yield were greatest under mains lights, and the plants under solar lamps were a distant second (Fig. 6). Measurement of the light intensity in the plots revealed the reason: the solar lights produced a bright, concentrated beam of light in one spot, with virtually no coverage over the rest of the plants. The mains lights had a more even distribution, so that more plants got at least 1 umole/m^2/sec. The average light intensity for the solar lamps was 1.1 +/- 1.3 umole/m^2/sec, while under mains it was 1.6 +/- 1.2 umole/m^2/sec. This indicates that currently available solar landscape lights are not suited for use of stimulating the daylength response of rudbeckia, but that a 9-watt fluorescent fixture every 6 ft. is sufficient to stimulate stem extension. 'Cherry Brandy' was not as productive as 'Prairie Sun', and was also later to come to flower.

Table 3. The effect of the type of light used to extend daylength in the fall on *Rudbeckia hirta* grown in a high tunnel, on stem length, yield and earliness.

Treatments	Stem length, cm		Stems/plant		First flower date, DAS	
	Prairie Sun	Cherry Brandy	Prairie Sun	Cherry Brandy	Prairie Sun	Cherry Brandy
Control	18	42	3.7	2.5	117	134
Solar lights	36	44	5.6	2.3	109	135
Mains lights	68	68	8.7	5.2	115	129
Stat. signif.						
Treatments	***		**		n.s.	
Varieties	***		***		***	
Vars. x Treats.	***		n.s.		n.s.	

Fig. 6. Solar lights on Rudbeckia in the high tunnel. Note the tall plant next to the lights, but short ones in foreground, where lights did not reach. Next plot down the row: no lights; far plot: button lights. Black curtain eliminates stray light from adjacent plots.

GODETIA TRANSPLANT STUDY:

When godetia is planted in spring into a high tunnel or field, growth is good, and the plants make attractive cut flowers, as long as the transplants have not been stressed. In 2008, a controlled experiment substantiated that late transplanting, especially after growth in small seedling cells, can severely stunt growth after transplanting. The current experiment was repeated to test these findings, and to find out if root growth is also adversely affected by the stunting.

Materials and Methods: The experiment was conducted with 'Apple Blossom' godetia (Thompson and Morgan). Seeds were sown on April 29, either into 210-cell or 72-cell trays. Treatments were as follows:

1. Transplanting May 26 from 72-cell tray
2. Transplanting May 26 from 210-cell tray
3. Transplanting June 10 from 72-cell tray
4. Transplanting June 10 from 210-cell tray
5. Transplanting June 10, after transfer May 26 from 210 to 72-cell trays

When plants began to flower, they were harvested, and fresh weight of the above ground parts and plant height determined. To gauge the extent of lateral growth of roots in the plots, the edge of the black plastic mulch was lifted on a 20 in. length of each plot, on both sides of the bed, and all the roots showing were counted. Plants were planted an average of 10 in. from the edge of the plastic.

Results and Discussion: The results of the experiment show the importance of timely transplanting (Table 4). Plants transplanted early, even from the 210-cell tray, grew vigorously and had the greatest height, fresh weight and root growth. Delaying transplanting two weeks, especially from small transplant cells, caused severe plant stunting, and reduced root growth, as indicated by the number of roots at the edge of the plastic. Late transplanting was associated with earlier flowering of the plants, presumably because they were able to grow actively for those extra weeks in the greenhouse, while the early transplants grew slowly in the cool spring conditions outdoors. Transplanting from small to larger cells and then planting in the field late gave similar results to late transplanting of large cells, so this treatment could be a technique used when field conditions don't allow timely planting. Growth of roots was parallel to above ground fresh weight, but more variable. The results of this trial were quite similar to those obtained in 2008.

Table 4. Effect of crowding in the seedbox and age of the transplant on performance after transplanting for 'Apple Blossom' godetia. For an explanation of treatment numbers, see Materials and Methods, above.

Treatment	Time to flower	Height at flowering, cm	Plant fresh weight, g	No. of roots at edge of plastic
1	68a[z]	89a	266a	22ab
2	69a	86a	237b	27a
3	62b	74b	58c	2b
4	62b	50c	19d	1b
5	61b	69b	59c	10ab
Stat. signif.	***	***	***	*

[z]Data followed by a common letter in a column are not significantly different at the 5% level using Duncan's Multiple Range test.

LISIANTHUS TRANSPLANT STUDY:

An experiment was conducted in 2008 to find out if crowding in the seedling tray and delayed transplanting could permanently stunt lisianthus transplants. The results were inconclusive, so it was repeated in 2009.

Materials and Methods: Lisianthus seeds were planted in 210-cell trays on Feb. 25 in a greenhouse, and either transplanted to the field on May 13, or transferred from the small cells to 72 cell-trays on that day. The latter and other seedlings in the 210-cell trays were transplanted on May 27, 2 weeks after the early transplants. There were two varieties: ABC 2-3 Blue, and ABC 1-3 White. Plants were spaced 9 x 9 in. in 4 rows, on plastic mulch. Stems were harvested when at least 2 flowers were open on a stem.

Results and Discussion: As in 2008, lisianthus showed very little reaction to delayed transplanting from small cells into the field. Overall, the yield was only half of that in the previous year, and stems were 15% shorter (Table 5). Although it would be tempting to attribute this to the cool, rainy early summer conditions, that does not explain why the 2009 trial flowered a week earlier. As in the previous year, 'ABC 1-3 White' had shorter stems and earlier flowering than 'ABC 2-3 Blue'.

The results appear to indicate that lisianthus is less sensitive to seedling stress than godetia.

Table 5. Effect of transplant cell size and date of transplanting on yield of stems per plant, stem length and date of first harvest of two varieties of lisianthus grown in the field.

Treatment	Stems/plant	Stem length, cm	Days to first flower
Early small	2.0	50.6	162
Late small	2.2	50.7	164
Early small, then large	1.4	52.1	162
Stat. significance	n.s.	n.s.	n.s.
ABC 2-3 Blue	2.0	55.1	164
ABC 1-3 White	1.7	47.2	161
Stat. significance	n.s.	***	**
Interaction signif.	n.s.	n.s.	n.s.

LARKSPUR TOPPING TRIAL:

When grown as an early crop in the high tunnel, most varieties of larkspur produce a long primary stem with relatively short and useless branches. With many cut flower species, apex removal when the plants are elongating rapidly in the vegetative stage results in the production of several stems of acceptable length per plant. With some species, however, a reduction of plant population is necessary for that advantage to be realized. It is thought that the lacy foliage of larkspur and supposed lack of interplant competition may make this spacing adjustment unnecessary. Accordingly, the present trial was conducted at a 6 x 6 in. spacing.

Materials and Methods: Treatments consisted of an untopped control, and apex removal of the seedlings, leaving 6 basal nodes. The varieties Stiletta Rosy Red (Kieft Seeds), Stiletta Indigo Blue and Sublime White (Johnny's) were compared. Seeds were started in **72 cell trays** on March 4 in artificial soil mix, refrigerated for one week, before being placed in a greenhouse for the seedling growth phase. Seedlings were transplanted on April 20 into the high tunnel, at a 6 x 6 in. spacing, with 5 rows per bed. There were 30 seedlings per subplot, and two replications.

Results and Discussion: Apex removal produced a positive effect in the three varieties tested in this trial. There was a 42% increase in the number of stems harvested per plant (Table 6), and stem length was also slightly increased. The average stem length shown in the table consists of the length of the main stem, which averaged 97 cm across the three varieties, and three branches averaging 54 cm length. Topping stimulated increases in branch length, and more branches to reach marketable length (Fig. 7). Topping delayed flowering by an average of 5 days. 'Sublime White' had significantly greater stem length and a delayed flowering date compared to the other two varieties. All three varieties reacted the same way to topping.

The results of this trial indicate that apex removal is a worthwhile strategy for larkspur when planted at a 6 x 6 in. spacing. If market requires a longer stem than the topped plants will produce, a more crowded spacing, to about 4 x 4 in., might be advisable, to obtain only the taller main stems from more plants.

Table 6. Stem length, productivity and earliness of three larkspur varieties grown in early spring in the high tunnel, comparing plants topped at node 6 with untopped control plants.

Variety/treatment	Stem length, cm	Stems/plant	Days to first flower
Stiletta Rosy Red	64	5.4	104
Stiletta Indigo Blue	57	4.6	102
Sublime White	77	4.6	108
Stat. signif.	***	n.s.	***
Control	65	4.0	102
Topped	68	5.7	107
Stat. signif.	*	*	***

Fig. 7. The larkspur topping trial in the high tunnel.

STOCK (MATTHIOLA) TOPPING TRIAL:

Damage due to mice or rabbits on stock plants growing in the high tunnel occasionally results in production of several stems per plant. To determine if stem yield increases could be achieved by pinching, we transplanted four stock varieties to the high tunnel on April 20 and topped at the 6th node on May 6. The four varieties were Vivas Pink, Vivas Clear Lavender, Cheerful Yellow and Prouesse Deep Blue. The results were very clear: only one topped plant in the entire experiment produced any flower; the rest failed to branch below the pinch, and produced nothing but leaves (Fig. 8) It is therefore not advisable to pinch the current stock varieties; they are non-branching.

Fig. 8. Stock plant topped and not showing any growth of branches. Picture taken 23 days after apex removal.

STOCK (MATTHIOLA) DATE OF PLANTING TRIAL:

Stock grows best in cool weather conditions, so must be transplanted early, before the onset of summer temperatures. Whereas transplanting into a high tunnel permits an early start, conditions become unfavorable earlier as well. In 2008, two sensitive varieties were partly inhibited from flowering by a May 2 transplant date, so the current trial was designed to test the relationship of transplanting date and plant performance once more.

Materials and Methods: Four varieties of stock of contrasting cold requirements for flowering were sown on three dates in seedboxes, grown under relatively cool conditions until transplanting about 40 days later, and then placed in the tunnel. The varieties used were Cheerful Yellow and Prouesse Deep Blue (Gloeckner), Vivas Blue and Vivas Salmon Pink (Sakata). The sowing dates were March 4, March 18 and April 1, with transplant dates of April 14 and 27, and May 11, respectively. Seedlings were grown in 72-cell trays, and transplanted to a 6 x 6 in. spacing with 5 rows per bed, and 30 plants per plot. There were 2 replications per planting date.

Results and Discussion: In the 2008 time of planting trial, 'Prouesse Deep Blue' showed some tendency toward inhibition of flowering at the latest transplant date. In the current trial, it flowered normally in all plantings (Table 7). The other 3 varieties included 'Cheerful Yellow', also used in 2008, and none of them showed delay of flowering in any of the plantings. Other plant characteristics measured did not vary systematically with planting date, although statistical analysis indicated significant interactions between varieties and planting dates in stem length, leaf number per plant and time of flowering. Temperature records for the 21-day period after transplanting also did not show a systematic variation in temperatures that could explain variations in stem length and leaf number. Minimum temperatures averaged 41F and average temperatures 54F in the three plantings, as measured at the weather station about a mile from the experiment. Unfortunately, the temperature sensors in the tunnel were not functioning at the time of the trials, so actual plant temperatures could not be verified.

The results of this trial appear to indicate that flowering of the four varieties in this season was not affected negatively by the temperatures experienced by the plants. Combined with the results of the 2008 trial, we conclude that early stock varieties can be successfully grown as cut flowers in early high tunnel plantings in Zone 5.

Table 7. Effect of dates of sowing and transplanting to a high tunnel on flowering time, stem length, leaf number at flowering and percent of plants with single flowers for four varieties of stock grown in 2009.

Treatments	Planting date	Cheerful Yellow	Prouesse Deep Blue	Vivas Blue	Vivas Salmon Pink	Interact. signif.
Flowering date, DAS	1	79	83	76	77	
	2	65	70	69	69	***
	3	68	80	70	74	
Stem length, cm	1	54	43	44	47	
	2	45	42	44	50	***
	3	48	54	48	62	
Leaf no. per plant	1	27	25	21	22	
	2	20	20	18	20	**
	3	21	29	18	24	
Single flowering, %	1	5	20	56	30	
	2	5	34	45	51	*
	3	5	54	37	40	

SUNFLOWER DAYLENGTH SCREENING TEST:

Screening sunflower varieties for response to daylength has been an ongoing part of our trials. Daylength response determines the stature and earliness of flowering of sunflowers planted in late March or early April, usually in high tunnels or unlighted greenhouses. Past trials have shown many sunflower varieties to be facultative short day plants, which are dwarfed by sowing in short-day conditions.

Materials and Methods: Nine new cut flower accessions of sunflower were compared to two standard lines of known daylength response. The screening test consists of sowing the seeds in 72-cell trays in a greenhouse, exposing the emerging seedlings to either 12 or 16 hours daylength for the first three weeks after emergence, and then transplanting them to the field. Field conditions consisted of 4-row beds with 9x9 in. spacing, black plastic mulch and trickle irrigation. The experiment was conducted twice, with sowing dates of May 14 and June 5, and transplant dates of June 10 and July 1, respectively. There were 24 plants per plot.

Results and Discussion: Of the nine varieties screened in 2009, four were ranked as day-neutral, four were strongly short-day in response, and one was intermediate (Table 8). As in previous years, plants that had received the short and long day treatments in the seedling stage showed very little difference in plant height at flowering and flower diameter (Table 9) if they were classed as day-neutral. Strongly sensitive short day lines were nearly twice as tall after the long day treatment compared to receiving short days as seedlings.

Table 8. Effect of a 3-week exposure in the seedling stage to either 12 or 16 hrs daylength on days to flower and plant height at flowering for nine cut flower cultivars screened in 2 replications.

Sensitivity type	No. of lines	Days to flower		Plant height at flowering, cm	
		Short day	Long day	Short day	Long day
Daylength neutral	4	70	67	123	116
Mod. short day	1	54	63	23	44
Strongly short day	4	53	75	76	137

In Table 9, the detailed reaction of each of the tested varieties is given. The correlation of plant height and flower diameter is evident, as is the relation of flowering date and plant height. The short stature of 'Big Smile' makes it more suitable for pot culture than cut flower use. 'Procut Brilliance' and 'Buttercream' were delayed in flowering after short day treatment in the first planting, but in the second one, both treatments flowered at the same time. This may indicate the influence of other factors in the post-transplant period such as temperature, but that work remains to be done.

Table 9. Reaction of nine sunflower varieties to exposure to seedling daylength treatments of 12 (short day) or 16 hours (long day) with regard to time of flowering, stem length at flowering and flower disk diameter.

Variety	Days to flower		Plant height, cm		Flower disk diameter, cm	
	Short day	Long day	Short day	Long day	Short day	Long day
Big Smile	54	63	23	44	3.9	5.2
Buttercream	66	63	143	133	5.6	5.2
Peach Passion	63	62	68	65	3.9	4.1
Procut Brilliance	68	64	122	118	8.2	7.8
Sunrich Lemon Summer	51	72	68	121	4.2	8.6
Tapuz	54	77	85	151	4.8	9.5
Terra Cotta	83	80	160	147	6.1	5.8
Zahav	55	77	91	157	4.8	9.8
Zohar	51	72	59	121	4.0	8.1

To describe the varieties in the trial, ‘Big Smile’ is a dwarf variety not suited to cut flower use because of its short stem, and tendency to produce multiple buds. ‘Buttercream’ is a tall, branching, day-neutral line with pale yellow petals and a dark center (Fig. 9). ‘Peach Passion’ is a short, mid-season branching line with small stature. It was conspicuous in having poor seedling vigor, and cannot be recommended. ‘Procut Brilliance’ produces strong stems and bright orange-petaled flowers with dark centers (Fig. 10). It is promising and noteworthy for not being sensitive to daylength, unlike most orange cut flower lines. ‘Sunrich Lemon Summer’ has pale yellow petals and a dark center, and is attractive under long day conditions but dwarf in short days. ‘Tapuz’ and ‘Zahav’ are standard orange types with relatively late maturity in long days, but very sensitive to daylength. ‘Zohar’ is of similar earliness to ‘Sunrich Orange’, and also daylength sensitive. ‘Terra Cotta’ was the latest cultivar in the trial, tall, with dark petals and flower center. It is a branching type, but has weak stem as a seedling, and at flowering, making it subject to lodging.

Fig. 9. Procut Brilliance sunflower.

Fig. 10. 'Buttercream' sunflower. Note small bud to left of front flower, a branch from lower on the main stem.

HIGH TUNNEL TULIP TRIAL:

High tunnels growing cut flowers tend to be empty from early November to the following April. That unused space might be used for production of a cut flower crop of tulips, especially if the crop could be harvested significantly earlier than tulips grown outdoors. Accordingly, in collaboration with Dr. Bill Miller of the Cornell Flower Bulb Program, we tested four varieties in three planting methods.

Materials and Methods: To determine if the high tunnel environment would provide sufficient cold to vernalize the tulips and induce flowering, three methods of planting were compared:

1. Planting directly in the tunnel bed
2. Planting in bulb crates in artificial soil-less mix, and burying these in the tunnel
3. Planting in crates in soil-less mix, vernalizing in a cold storage, then planting in March in the tunnel beds

Varieties:

1. Passionale
2. Leen van der Mark
3. Purple Flag
4. World's Favorite

The experiment was designed as a split plot, with planting methods as main plots, and varieties as subplots. There were 2 replications, with 40 bulbs per variety in each subplot. Crates and beds (treatment 1) were planted Nov. 17, and the cold-stored crates were planted in the high tunnel on March 11.

Results and Discussion: Growth of the plants in this trial was not satisfactory, largely because there was no source of irrigation over the winter in the high tunnel. This necessitated hand watering with water brought it from distant sources. In addition, worries about late winter frosts after the plants had emerged motivated us to erect a low tunnel of Tyvek spunbonded white fabric over all plots on March 11. In subsequent sunny weather, temperatures under the cover might have gotten too high. Air temperatures in the high tunnel reached over 80 F on four occasions in late March, with one incidence of 105 F. Temperature in the low tunnel was not recorded.

As a result, a majority of plants in the crate treatments did not produce harvestable flowers, with flower buds aborting or withering before opening (Table 10). In general, plants grown in the soil of the beds did much better, with most coming into flower. First flowers were harvested on April 6, and concluded about April 13. Comparing the varieties used, Leen van der Mark and Purple Flag had slightly higher number of harvestable stems.

The results indicate that future plantings of tulips in high tunnels will require more frequent watering, and temperature control will have to be improved, especially on sunny days, to prevent excessive heat buildup.

Table 10. Response of 4 tulip varieties to growth in the high tunnel in 2008/2009.

Varieties	Treatments	Non-flowering, percent^{z}	Stem length, cm
Passionale	1	25	32
	2	86	--
	3	94	24
Leen van der Mark	1	3	36
	2	80	28
	3	44	23
Purple Flag	1	8	31
	2	62	27
	3	89	28
World's Favorite	1	32	40
	2	72	33
	3	98	--

^{z}Plants not flowering or with withered buds

VARIETY TRIALS (in alphabetical order):

1. **CALENDULA**

Calendula is useful as a fall crop in the high tunnel, because it is somewhat frost hardy, and some of the flower colors are appropriate for fall.

Materials and Methods: Four varieties were sown on July 9 in the greenhouse and transplanted to the high tunnel on Aug. 11. Spacing was 9 x 9 in. in 4 rows on black plastic mulch. There were two replications, and 16 plants per plot, except for 'Greenheart Orange', which had 20. Pest control measures taken on the crop included two sprays of Milstop fungicide as powdery mildew control. Banker plants with barley aphids and their wasp predators were also introduced in the high tunnel for biological control of aphids in several crops.

Results and Discussion: The trial was productive, making good growth into the fall, and producing a steady yield of stems (Table 11). 'Maayan' and 'Antares Flashback' had similar flower appearance, with dark centers and dark orange backs of petals. 'Antares' was the shortest of the varieties. 'Greenheart Orange' represents an unusual flower type (Fig. 11), with a fuzzy yellow-green flower center surrounded by a pale green outer ring. Its appearance is similar to the aster variety 'Hulk'. The flowers were borne on a relatively thick stem of greater height than other varieties in the trial. 'Princess Sapporo' had a more traditional double flower appearance, with intermediate stem length and earliness.

Fig. 11. 'Greenheart Orange' calendula in the fall tunnel trial.

Table 11. Stem length, yield and flower dates (days after sowing) for four calendula varieties grown in the high tunnel in fall.

Variety and Source	Stem length, cm	Stem no./plant	First flower date
Maayan (Genesis)	41	9.9	57
Antares Flashback (Johnny's)	30	9.4	61
Greenheart Orange	48	6.2	72
Princess Sapporo	43	6.6	62

2. CAMPANULA

An attractive, long-lasting flower when grown in a high tunnel, Campanula 'Champion' has become a staple of early cut flower production. Although resembling the Canterbury Bell type of campanula, this series does not require a cold period to induce flowering.

Materials and Methods: Seeds were started for both high tunnel and field production, and transplanted at appropriate times. The high tunnel crop was sown on Feb. 26 and transplanted April 17; the field crop's dates were March 25 and May 8. Plants were grown in 72-cell trays in a greenhouse before setting out. There were 24 plants per plot, spaced 9 x 9 in. apart in four rows on black plastic mulch, in two replications. An additional plot of 'Champion Pink Improved' was pinched at node 6 on May 6 and May 8 for tunnel and field, respectively.

Results and Discussion: The stem length, and yield of the high tunnel crop gives a dramatic illustration of the value of this structure for production of some cut flower species (Tables 12,13). During the period just after transplanting of the field-grown crop, cool, windy and rainy conditions prevailed, stunting the plants permanently. As a result, high tunnel-grown plants had main stem lengths 63% longer than in the field, whereas branches were 83% taller. Yield differences were even more striking: 2.5 times greater in the high tunnel (Fig. 12).

Fig. 12. Campanula 'Champion Blue Improved' in the high tunnel trial.

The value of topping was more evident in the field than the tunnel experiment. Removing the growing point deprived the plant of a taller main stem, but increased yield from 3.5 (main stem plus branches) to 5.7. In the tunnel, yields of topped and untopped plants were similar, with the pinched plants flowering a week later than the controls (Table 12).

Table 12. Stem length, first harvest dates and branch characteristics of 5 campanula 'Champion' series varieties grown in the high tunnel in spring 2009. Additional plots of 'Pink Improved' were topped at the 6th node for comparison.

Variety	Stem length, cm, main stem	Harvest date, DAS	Stem length, branches	Branches per plant	Branch harvest date, DAS
White Improved	70	102	52	7.9	108
Lavender Improved	66	103	54	9.0	108
Blue Improved	67	104	52	7.2	109
Pink Improved	63	104	50	6.6	110
Blue	65	102	47	7.0	109
Pink Impr., topped	--	--	55	8.4	111

Table 13. Stem length, first harvest dates and branch characteristics of 5 campanula 'Champion' series varieties grown in the field in spring 2009. Additional plots of 'Pink Improved' were topped at the 6th node.

Variety	Stem length, cm, main stem	Harvest date, DAS	Stem length, branches	Branches per plant
White Improved	41	77	27	0.9
Lavender Impr.	42	79	27	1.1
Blue Improved	42	79	25	1.3
Pink Improved	40	82	32	2.5
Blue	38	79	27	1.8
Pink Improved, topped	--	86	32	5.7

Performance of the five varieties was similar in all respects, and I could also not detect differences between 'Champion Blue' and 'Champion Blue Improved'. In the 2008 variety trial, 'Champion Lavender' was about 10 days earlier in flowering than the other colors; in this trial, earliness was not different among the 'Improved' colors.

3. DELPHINIUM

Maintaining an adequate plant stand past the stage of first bloom has been a continuing problem with many of the varieties of delphinium that we have tried. Methods of keeping the soil cool with straw mulch or treating with special compost have also not made any difference in preventing plant death. The current trial sought to compare the decline in plant population as well as the height and productivity of four new lines in a field trial.

Materials and Methods: Seeds were sown in 72-cell flats in a greenhouse on March 24, and transplanted to the field on May 19. There were 15 plants per plot, spaced 12 x 12 in apart in three rows on black plastic mulch. There were two replications.

Results and Discussion: The results of this year's trial offered a ray of hope for our quest for a vigorous delphinium variety that maintains its plant stand at the end of the growing season (Table 14). 'Centurion White' and 'Magic Fountain Cherry Blossom' showed vigorous growth throughout the season, and still had two thirds of the plants surviving in the fall. The tallest variety, 'Centurion White' had fewer stems, whereas 'Magic Fountain' was productive with 5 stems per plant. Neither of these two varieties had a pure color, but showed somewhat greenish overtones, but that may be desirable in mixed bouquets (Fig. 13). 'Blue Donna' is a bellamosum type, with somewhat shorter stems, and the shorter vase life common to that type. 'Prism Sea Blue' is also a bellamosum type, but had a drastic reduction in stand by the end of the summer. The 'Guardian Mix' performed as usual in our trials, declining in stand precipitously.

Fig. 13. ‘Magic Fountain Cherry Blossom’ in the field trial.

The trial indicates that ‘Centurion White’ and ‘Magic Fountain Cherry Blossom’ are worth another look.

Table 14. Stem length, yield, first flower date (days after sowing) and plant stand 4 months after transplanting, for five delphinium varieties planted in the field.

Variety and source	Stem length, cm,	Stems per plant	First flower date, DAS	Plant stand on Sept. 23, %
Blue Donna (Kieft)	46	6.3	92	40
Centurion White (Gloeckner)	62	3.1	96	67
Prism Sea Blue	46	5.0	91	3
Magic Fountain Cherry Blossom (Geo)	53	5.0	106	67
Guardian Mix (Harris)	38	1.8	100	3

4. DIANTHUS

Since the traditional Sweet William has been transformed into an annual that can flower without the need for a cold treatment, new varieties of dianthus have been coming out at regular intervals, and some, such as the 'Amazon Neon' and 'Sweet' series, have become quite popular. Two new lines were planted in the field in 2009 to compare with 'Amazon Neon Cherry'.

Materials and Methods: The varieties were sown in the greenhouse on March 18, and transplanted to the field on May 11. Plants were spaced at 9 x 9 in., with 24 plants per plot and two replications. Harvests began in early June, and continued through the summer.

Results and Discussion: 'Fandango Purple Picotee' was comparatively early, and tremendously productive, but did not have adequate stem length (Table 15). In addition, only a few florets opened on each flower head at one time, and would fade quickly, so that the flower display was not showy. 'Bouquet Rose Magic' had more attractive, pink-lavender florets with serrated edges, and somewhat taller stems. The strong, large umbels of 'Amazon Neon Cherry' were later, but impressive in their stature. In general, dianthus produces its strongest stems early in the flowering season, and then declines to smaller, weaker stems the rest of the season. When initial stem length is already limiting, the later harvests can only be used in small bouquets.

Table 15. Stem length, yield and first harvest date (days after sowing) of three dianthus varieties grown in the field in 2009.

Variety and source	Stem length, cm,	Stems per plant	First flower date, DAS
Fandango Purple Picotee (Goldsmith)	32	38	85
Bouquet Rose Magic (Gloeckner)	37	29	100
Amazon Neon Cherry (Harris)	42	13	106

5. ERYNGIUM

A perennial also known as sea holly, this genus has varieties bred to flower in the first year. Flower heads and bracts are brightly colored, and can be preserved by drying. We compared two lines of E. planum, Blue Glitter and White Glitter, and two lines of E. leavenworthii, 'Purple Sheen' and 'Sea Holly'.

Materials and Methods: Seeds were sown on Feb. 26 in the greenhouse, and seedlings transplanted on May 13. Plants were spaced 12 x 12 in. in the field, and there were two replications. Although it was intended to have 18 plants in each plot, poor seed germination reduced field populations to half that in one variety. Stem harvests were made when the main flowers on the stem reached anthesis.

Results and Discussion: At the 12 x 12 in. spacing, plants developed well-branched stems that were only moderately useful in arrangements. Pinching or closer spacing might have produced stems with fewer branches and needs to be tried. The two ‘Glitter’ varieties were similar in most respects except flower color. The medium length flower heads with short bracts were uniform and attractive. ‘White Glitter’ had a greenish-white inflorescence at anthesis; ‘Blue Glitter’ a metallic pale blue (Fig. 14).

Fig. 14. Eryngium ‘Blue Glitter’ in the field trial.

An unpleasant odor of wet dogs was noticeable at anthesis, but faded later in the season. Plants maintained their stand through the season, and would probably perennialize if given the chance. ‘Purple Sheen’ and ‘Sea Holly’ appeared to be the same variety, resembling each other in all ways. Unfortunately, many of its characteristics were undesirable: primarily susceptibility to root rot and plant collapse, which reduced initial stands to half by the time of flowering. In addition, a necrosis of the plant tip, and later, the top bracts on the flower head made many flowers unmarketable. Without these problems, the electric purple of the flower head and prominent bracts would make this variety an attractive cut flower (Fig. 15). Yields of the ‘Glitter’ varieties were considerably higher than the other two (Table 16). In general, the long period required to bring the plants to flower make it impractical to grow Eryngium only as an annual.

Table 16. Stem length, yield and first harvest date (days after sowing) for four Eryngium varieties grown in the field in 2009.

Variety and source	Stem length, cm,	Stems per plant	First flower date, DAS
White Glitter (Benary)	46	6.2	170
Blue Glitter (Harris)	51	6.8	170
Purple Sheen (Geo)	81	2.6	182
Sea Holly (Thompson and Morgan)	79	4.0	192

Fig. 15. Eryngium leavenworthii ‘Sea Holly’

6. GOMPHRENA

Globe amaranth (*Gomphrena globosa*) is a heat-loving annual that grows well in both high tunnel and field. Useful as a filler in bouquets, it is a productive plant that can supply many stems all summer long.

Materials and Methods: Seeds for both trials were sown on April 15 and transplanted on May 20, with a spacing of 12 x 12 in. and 3 rows per bed. The field trial had two replications; in the high tunnel, space limitations restricted the planting to one replication only. There were 15 plants per variety per plot. Harvests continued from July 6 to the end of the growing season.

Results and Discussion: Gomphrena grew well in both trials, and produced respectable yields (Table 17.) The two 'Audray' varieties were particularly noteworthy with their tall, strong stems and good yields (Fig. 16).

Fig. 16. 'Audray Pink' gomphrena in the field trial.

Plants performed noticeably better in the tunnel than outside, were a week or more earlier, and had higher yields of taller stems. The 'Las Vegas' series was shorter and weaker of stem and thus not as desirable. 'All Around Purple' compared well with the Audray lines, and was somewhat earlier, so is by no means outmoded.

Table 17. Stem length, yield and days to flower (sowing to first bloom) of six gomphrena varieties grown in the field and the high tunnel in 2009.

Name and (Source)	Stem length, cm^z		Stems per plant		First harvest date	
	Tunnel^z	Outside	Tunnel^z	Outside	Tunnel^z	Outside
Audray Pink (Takii)	72	60	21	13	104	112
Audray Purple Red	69	61	18	11	93	112
Las Vegas Pink (Benary)	56	48	23	11	84	91
Las Vegas Purple	53	46	14	11	82	89
Las Vegas White	56	46	14	9	93	112
All Around Purple (Harris)	56	51	20	13	82	86

^{z}Only one plot per variety in the high tunnel

7. **LISIANTHUS**

Lisianthus (*Eustoma grandiflora*) continues to be one of the most popular of cut flowers, with new varieties being actively developed every year. That was also the case in 2009, when 8 new lines were submitted for testing in the ASCFG trials, and were planted here.

Materials and Methods: The variety trial was conducted in the high tunnel, and some of the lines were also grown in the field. For the high tunnel, seeds were started Feb. 16 in the greenhouse, and transplanted to the tunnel May 8; the field planting was seeded on March 5 and transplanted May 22. Insufficient seed restricted the latter to 6 varieties, compared to a total of 9 varieties in the high tunnel trial. In both locations, plants were spaced 9 x 9 in. apart in 4 rows, on black plastic. There were two replications. Harvest started in mid-July for the earliest cultivars and continued to late October. The field planting began flowering in early to mid-August.

Results and Discussion: The cold and wet weather was particularly challenging for the field planting of this trial in 2009. As a result, yields were less than half of those grown in the tunnel, and stem length was also shorter for most of them. Plants in the tunnel trial grew well, and produced excellent yields (Table 18).

Varieties that were notable in the high tunnel trial included ‘Cinderella Lime’, a double petal type with excellent yield and mid-season maturity (Fig. 17). ‘Borealis Apricot’ is somewhat later, but has an interesting uniform pink petal color (Fig. 18). Among the single petal varieties, ‘Magic Deep Blue’, and ‘Advantage Purple’ were productive in the tunnel, and had an attractive deep color. ‘Magic Deep Blue’ was the only variety producing more than 3 stems per plant in the field (Fig. 19).

Fig. 17. Lisianthus ‘Cinderella Lime’ in the high tunnel trial.

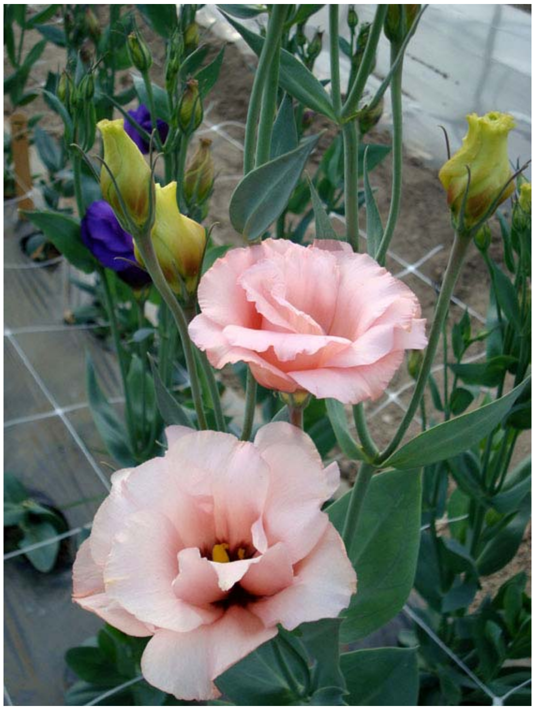

Fig. 18. Lisianthus 'Borealis Apricot' grown in the high tunnel trial.

Fig. 19. Lisianthus 'Magic Deep Blue' grown in the high tunnel trial.

Table 18. Stem length, stem yield and first harvest date for nine lisianthus varieties grown in the tunnel, and six grown in the open field in 2009.

Name and (Source)	Stem length, cm[z]		Stems per plant		First harvest date	
	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Cinderella Lime (Goldsmith)	61	51	7.0	2.0	156	158
Arena 3 Champagne (Takii)	54	--	4.6	--	162	--
Vulcan 2 Purple Picotee	48	--	2.9	--	161	--
Vulcan 2 Campagne	67	--	5.4	--	162	--
Borealis Apricot (Gloeckner)	52	52	4.9	1.2	160	172
Magic Deep Blue	62	51	5.7	3.8	158	156
Super Magic Yellow	58	61	2.6	2.3	172	178
Advantage Purple	59	51	6.6	1.8	154	170
Echo Champagne (Johnny's)	56	46	7.4	2.2	143	156

8. SNAPDRAGON

Cut flower breeding programs are continuing to develop new snapdragon (*Antirrhinum majus*) varieties with adaptation to both high tunnel and field conditions. Some of these are distinctly earlier in coming to flower than the traditional summer field varieties such as the 'Rocket' series. We grew 5 varieties in a spring trial planted in the field, and six in a fall high tunnel trial.

Materials and Methods: The field trial was sown on March 25 in the greenhouse, and transplanted May 13 to the field. The high tunnel trial was sown May 27 and transplanted July 14. There were two replications of 24 plants per plot in each trial. The spacing used was 9 x 9 in. in 4 rows per bed, and two replications. 'Trumpet Pearl' was only planted in the high tunnel trial.

Results and Discussion: In the relatively cool summer, the field trial grew well and produced stems all summer, resulting in good yields (Table 19). The tunnel trial also performed well, but since flowering did not start until early August, had a relatively shorter season of harvest. The standard 'Rocket White' gave similar yields to the new varieties, but was significantly later in flowering. 'Calima Yellow' was relatively early, but florets were spaced a bit far apart on the spike. It also tended to lose florets after harvest when in arrangements. From limited tests, it appeared as if this abscission did not require pollination first, but this needs to be checked further. 'Appeal Scarlet' was of similar maturity to 'Calima Yellow' but had a denser floret spacing and an attractive medium red color (Fig. 20). 'Opus Bright Red' had darker red, velvety florets on strong, tall stems. The only detracting factor was a tendency for the tip to break off if not handled very gently. 'Axiom White' was of 'Opus' maturity, with long spikes of attractive white standard florets. 'Trumpet Pearl' was relatively early and productive in the tunnel, and worth another look in the field and tunnel. It has open-face florets, well spaced on the head. The trials indicate that there are a number of attractive, productive snapdragon varieties that perform well in both high tunnel and field, and are an improvement over the standard 'Rocket' lines.

Fig. 20. Snapdragon 'Appeal Scarlet' in the field trial.

Table 19. Stem length, yield and first harvest dates (days after sowing) for five snapdragon varieties grown in a spring-planted field trial, and six varieties in a summer-planted trial in the high tunnel.

Name and (Source)	Stem length, cm		Stems per plant		First harvest date	
	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Opus Bright Red (Goldsmith)	87	81	4.6	7.3	70	82
Rocket White (Harris)	65	64	5.5	8.7	78	99
Calima Yellow (Gloeckner)	70	64	5.6	9.0	68	77
Appeal Scarlet	61	67	6.1	9.4	68	79
Axiom White (Geo)	83	72	5.4	7.3	71	80
Trumpet Pearl(Gloeckner)	74	--	6.6	--	66	--

9. ZINNIA

Zinnia is another species that lends itself to summer production in the open field, and fall production in the high tunnel. The present trials were planted to test new varieties in both these environments.

Materials and Methods: The spring field trial was sown in the greenhouse on April 24 and transplanted May 26. The high tunnel trial was sown July 14 and transplanted Aug. 11. In the field and high tunnel, plant spacing was 9 x 9 in. in 4 rows, with 2 replications. Disease and insect pressure was high in the field experiment. Aphids appeared early and were controlled by a spray of neem. Then *Alternaria zinnae* appeared, and was controlled using Cease biofungicide. Japanese beetles were also numerous, and required treatment twice with a conventional insecticide. The high tunnel experiment required treatment of powdery mildew and botrytis grey mold on three occasions. Milstop was used twice, and Cease once, at roughly weekly intervals. The treatments prevented serious defoliation of the plants.

Results and Discussion: As with the snapdragon trials, above, the productivity of zinnias was much better in the summer field trial than in the tunnel trial in the fall. In the case of zinnias, the first plants in the tunnel flowered in the second week of September, so there was only a short growing season left. The field trial began flowering in late June, and so had the whole summer to produce flowering stems.

There were several attractive varieties among these entries. 'Red Beauty' bore a medium sized flower of bright red color and excellent stem length (Fig. 21). 'Benary Giant Wine' continues the good reputation of the series with an interesting red-purple color (Fig. 22). As with the others of this class, fewer of these large flowers are produced than varieties of smaller size, such as 'Scabious Flowered Mix', for instance (Table 20). The latter did not live up to its description, and its flowers looked like relatively small singles rather than resembling scabiosa. 'Queen Red Lime' featured outer green and inner purple coloring on its medium-sized flowers, but left something to be desired with regard to uniformity of color and attractiveness. 'Inca' was only grown in the high tunnel, and although its flowers were a bright orange with ragged-looking petals, stem length was not impressive. 'Uproar Rose' again impressed with its good height, and large, uniformly double flowers.

Fig. 21. Zinnia ‘Red Beauty’ in the summer field trial.

Fig. 22. Zinnia ‘Benary Giant Wine’ in the summer field trial.

Table 20. Stem length, yield and first harvest date (days after sowing) for seven zinnia varieties grown in the tunnel in the fall, and five of which were planted in the field in summer.

Name and (Source)	Stem length, cm[z]		Stems per plant		First harvest date	
	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Red Beauty (Genesis)	60	63	1.7	6.9	62	66
Benary Giant Wine (Benary)	55	58	1.6	5.8	66	72
Queen Red Lime (Johnny's)	56	59	3.2	9.0	62	77
Inca (Harris)	48	--	1.8	--	59	--
Peppermint Stick	59	48	3.4	6.8	58	78
Scabious Flowered Mix (Thompson and Morgan)	63	50	7.5	9.6	58	64
Uproar Rose (Goldsmith)	62	--	3.0	--	59	--

10. MISCELLANEOUS

A. Panicum 'Frosted Explosion'

The search for a delicate filler for bouquets of larger flowers has come up with this species as part of the ASCFG trials for 2009. We sowed the seeds in the greenhouse on April 15 and transplanted to the field on May 27. Plants started to flower a month after transplanting, and we harvested from them until end of August. Stem length started at about 50 cm, but increased to about 80 cm for most of the season, averaging 87 cm. Productivity was an amazing 32 stems per plant on the plants spaced 12 x 12 in. apart. In arrangements, the stems tended to be somewhat weak, and needed support from surrounding flowers. Other growers have warned that the seeds produced could become a weed problem. With these caveats, this species is worth growing again (Fig. 23).

Fig. 23. Panicum 'Frosted Explosion'.