CUT FLOWER CULTURAL PRACTICE STUDIES AND VARIETY TRIALS 2014

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EXECUTIVE SUMMARY:

After a cold winter, growing conditions in spring and summer were near normal, and experiments generally grew well. A recurring problem of high pH in the medium for early-sown trials, and then again in the high tunnel and in the field negatively affected growth of some trials. Overall, much useful information was obtained, as shown in the following pages.

Anemone Ranunculus trial: (Page 6). The experiment was planted in the high tunnel in December 2013 and compared the effect of pre-germination of corms and low tunnel cover on two varieties each of anemone and ranunculus. Use of low tunnels increased stem length and advanced flowering by 11 days, but had no effect on yield. Pre-sprouting reduced plant stand, especially of ranunculus, perhaps because of dry conditions in the tunnel soon after planting. As in the previous year, the trial showed that these crops can be successfully grow in winter and early spring in an unheated greenhouse.

Sunflower Photoperiod Reaction Trial: (Page 9). Nineteen varieties of sunflowers grown as cut flowers were screened for their sensitivity to the daylength in the first 3 weeks after emergence. A majority (58%) were found to be sensitive, flowering more than a week earlier when given 12 hrs. photoperiod, compared to 16 hrs. Only one was hastened to flower after long day treatment, and 37% were daylength neutral.

Defoliation of peppers with ethephon: (Page 15). Two species of pepper (*C. annuum* and *C. baccatum*) were treated with a foliar spray of ethephon to bring about leaf removal, but initial concentrations of up to 1000 ppm had no effect. A repeat application using five times as much showed leaf and pod drop, especially on *C. baccatum*, and pointed out the difficulty of retaining pods while dropping leaves.

Pepper variety trial: (Page 16). Six lines of *C. baccatum*, and one line and 6 named varieties of *C. annuum* were evaluated for their attractiveness when harvested as fruit-bearing stems at maturity. A hydration study showed that *C. baccatum* remained well hydrated in the vase for 2 weeks after harvest, whereas the *C. annuum* material tended to wilt. Use of a hydrator slightly improved performance. An unreplicated application of 5000 ppm ethephon dropped nearly all fruit and most leaves from *C. baccatum* lines, but had less drastic effects on *C. annuum*.

Lisianthus Spacing and Topping trial: (Page 20). This experiment to determine if lisianthus yield could be improved by closer spacing and by pinching out the main growing point in the vegetative stage was conducted in both high tunnel and field. The results indicated that the combination of practices could boost the yield of stems by 80% over planting the crop at 9 x 9 in. spacing and not pinching. Pinching delayed flowering by 6 days, but led to an 8% increase in stem length.

Celosia comb deformation trial: (Page 23). When grown in a high tunnel or in the field, cockscomb celosia often has deformed flowers. We tried to reproduce that effect by subjecting the plants to cool conditions in the early transplant stage. Application of 60-50 F during the time that the plant growing

point is just reaching reproductive development succeeded in one instance in deforming the flower, but not in a second attempt. Understanding the connection between flower development and temperature will require additional work.

Overwintering Snapdragon in the High Tunnel: (Page 25). In 2013 a snapdragon variety trial that was planted in the high tunnel for fall harvest showed that significant harvest could be obtained from the over-wintered plants. Five of the 7 varieties had more than 60% of plants surviving into spring, and these produced an additional 79% stems compared to the fall harvest. Plants started flowering at the end of May, several weeks earlier than a spring-planted crop could be harvested.

Delphinium Longevity trial: (Page 28). Delphinium varieties differ markedly in the length of time they grow actively and yield under our field conditions. Some varieties such as the Centurion series maintained close to perfect stands over several years, while others, such as the Candle and Guardian series showed a rapid decline in plant survival. In the current variety trial of 7 accessions, two Centurion lines (White and Rose) and Pacific Giant Percival had the best survival rate.

Cut Flower Variety Trials

Ornamental Alliums: (Page 29). Eleven species of Allium were planted in the field, but only 9 survived the winter. Of these, flowering dates ranged from mid-May to early July, with vase life of two weeks. Longevity will be tested by leaving the trial in the field for 2015.

Ammi: (Page 31). The four Ammi varieties tested grouped into a couple of pairs that flowered nearly 30 days apart. All were very productive, with 27 stems per plant, and made attractive fillers in mixed arrangements. 'Orlaya' was twice as productive as the Ammi lines, but stems stayed short.

Celosia: (Page 33). We compared 5 varieties of plume type celosia in a field planting, and found them to be productive and generally colorful. 'Sunday Orange' appeared the most promising.

Cosmos: (Page 34). Of the four varieties tested, three tended to be somewhat leafy, with relatively inconspicuous flowers. 'Double Click Rose Bonbon' had larger, attractive flowers but was attacked by powdery mildew that limited its yield.

Delphinium: (Page 36). A supplementary trial with 4 varieties was planted in the field, but was adversely affected by high pH in both the seedling tray and in the field, so that stem lengths and productivity were not up to expectation.

Eucomis: (Page 36). Pineapple lily in the high tunnel continued to be very productive, giving more than 3 stems per plant in spite of becoming increasingly crowded after 3 years of growth. A new tunnel planting indicated that bulbs need to reach at least 15 cm circumference to produce flowers. While Eucomis survives very well in the tunnel, we found that during the cold winter of 2013-14, only plants that were mulched with wood chips survived under field conditions.

Filler species: (Page 41). The species tested provide primarily foliage to fill out bouquets. Some provided early stems, but had poor sustainability through the season. These included *Bupleurum*, *Euphorbia* and *Gypsophilum*. Two varieties of *Eucalyptus* produced well, but useable stems could not be harvested until early September. More work is needed to increase the vegetative growth potential of the three early species.

Gladioli: (Page 43). Two varieties of glads were planted in both the high tunnel and the field at about 3 week intervals beginning in late May. Performance was good in both locations in the earlier plantings, all taking about 80 days to come to flower. In the July plantings the Border Mix variety showed increased foliar bleaching and declines in yield. The early August planting was too late to come to flower.

Poppies: (Page 44). Spring plantings of *P. rhoeas* in the tunnel and the field showed this crop to have beautiful but delicate flowers of very short vase life, unsuited for commercial production as a cut flower.

Ornamental Cabbage: (Page 46). This trial of 5 varieties was planted to the field in July at 6 x 6 in. spacing. In spite of this, the size of the apex of some varieties was rather large, suggesting that even more crowding is needed. Plants also tended to lodge at transplanting, resulting in crooked stems at harvest. More work is needed on cultural practices to overcome these constraints.

ACKNOWLEDGEMENTS: I am grateful for the expert assistance of Priscilla Thompson and Anna Enocksson in the conduct of these trials. Thanks also for the seed samples supplied by the following seed companies: Geo, Fred C. Gleckner, Harris, Johnny's Seeds, PanAmerican and Takii. The Association of Specialty Cut Flower Growers provided some of the seed for the variety trials, and partially funded some of the work, and for that I am very grateful. Additional support came from Federal Formula Funds, and the Walmart Foundation.

WEATHER CONDITIONS:

Rainfall amounts were close to the long-term averages through April 2014, but exceeded normal levels during the summer (Fig. 1). Temperatures were markedly below normal during the winter, then averaged at normal levels the rest of the season (Fig. 2). No severe frost had occurred by Nov. 7, although field plantings were terminated by late October.

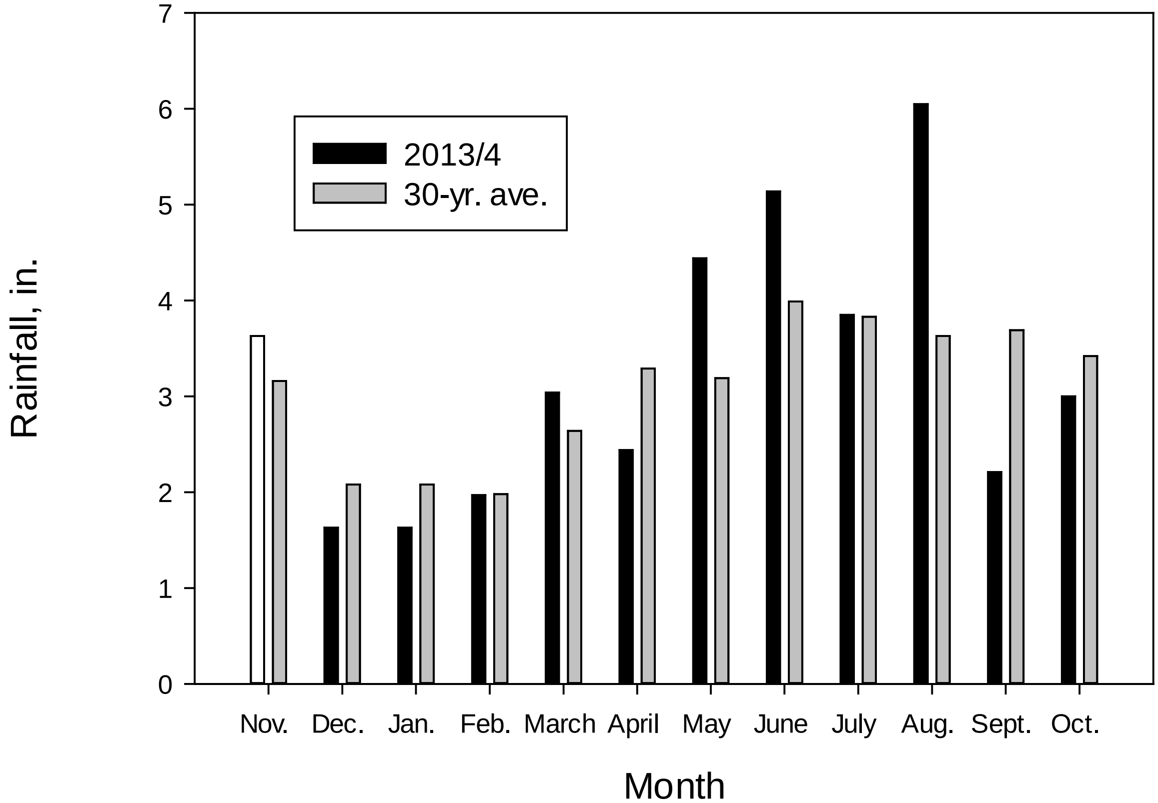

Fig. 1. Monthly rainfall totals for Ithaca for the 2013-2014 growing season, and the 30-year average, as determined by the Northeast Regional Climate Center. Measurements come from the weather station about a mile from our flower farm.

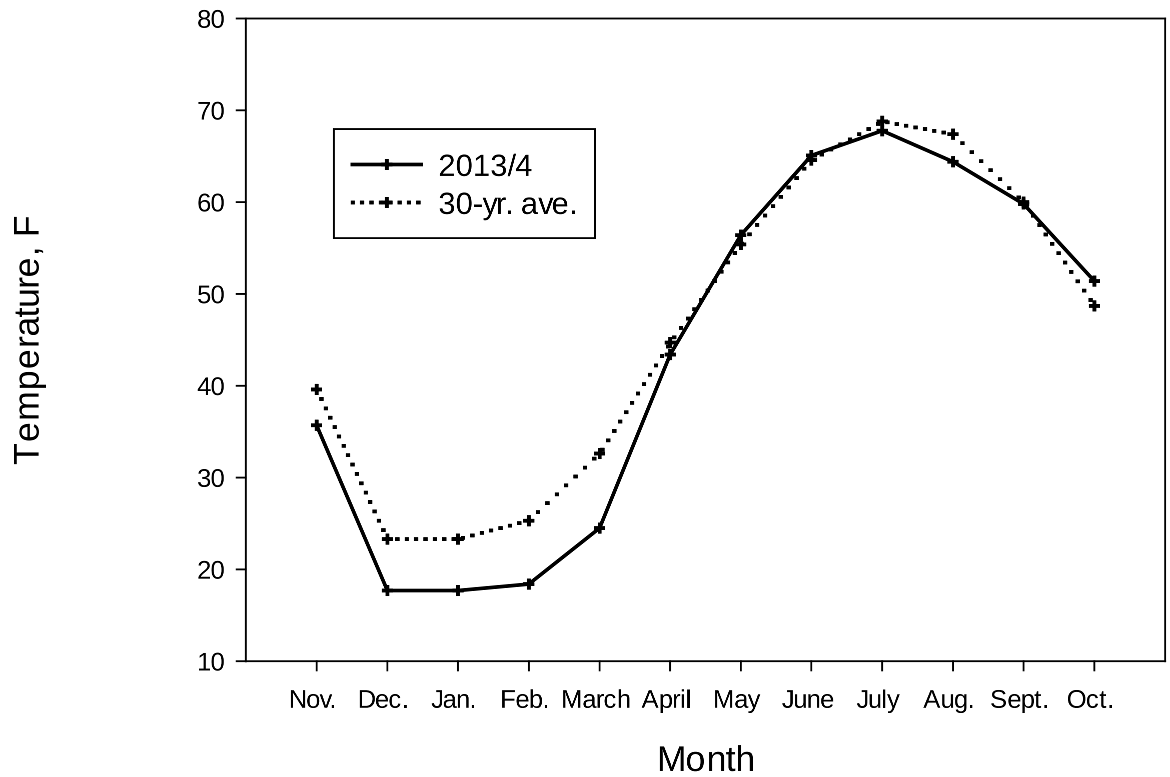

Fig. 2. Average above-ground temperature for the 2013-2014 growing season, compared to the 30-year average, for Ithaca, NY. Data from the NRCC (www.nrcc.cornell.edu/climate/ithaca/).

GENERAL MATERIALS AND METHODS:

The 2014 cut flower trials were conducted at East Ithaca Gardens, in both the field and the high tunnel. The latter has ground dimensions of 30 ft. width and 96 ft. length, with roll-up sides and end wall vents. The sides open under the control of a thermostat-controlled, battery-powered motor with max. and min. temperature settings of 65 and 85 F, respectiely. In the field, 2 in. of compost was applied in late fall 2013 and worked in. On May 11, 300 lbs. of a 20-10-10 was applied by machine to the field before beds were formed. Beds were made on 6 ft. centers, with dimensions of 5 in. height and 40 in. width, and covered with black polyethylene mulch, with two trickle irrigation lines under the mulch in each.

In mid-June symptoms of leaf yellowing and stunted growth appeared in the field, and we attempted to remedy the problem using application of calcium nitrate at the rate of 25 lbs. N per acre applied through the trickle irrigation system. It became apparent that high soil pH was the problem, and plants were suffering from iron deficiency. Soil pH varied from 7.6 to 8.0, probably caused by yearly additions of compost. A major component of our compost is manure derived from animal bedding in Cornell's barns, to which lime is added to reduce odor. Since most experiments had already been planted, we tried to remedy the problem with foliar sprays of iron chelate (Sprint 138 at 1.5 lb per 100 gal of water).

Supplementary nitrogen was given as ammonium sulfate at 25lb. N per acre, through the trickle irrigation. In spite of these measures, a sunflower topping experiment was too variable in growth to continue, and uneven growth occurred in the pepper variety trial and the lisianthus topping trial.

About an inch of compost was added in the high tunnel in late fall 2013 or early in 2014. Beds received 25 lbs/A N as calcium nitrate through the trickle in June, 2014. Spider mites and aphids were controlled by use of natural enemies applied in late August in the high tunnel. No pesticide sprays were needed in the field. Weed control in the pathways between beds in the field was achieved using shielded sprays of glyphosate, applied three times throughout the summer.

Plants for the variety trials were started in greenhouses from seed in seedling trays in Lambert LM-1 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. For trials of Campanula, Larkspur and Delphinium, the batch of mix used unfortunately had a high pH, with the result that seedling growth after sowing in early March was very slow. Attempts to remedy the problem using iron chelate sprays and pH adjustment were too harsh for the young seedlings, and many died. The survivors were then transferred to a LM 111 mix, and growth became more normal, but seedling numbers were reduced to half in some lines. The high pH problem recurred in the field (see above) where it affected growth of the delphinium trial, and in the high tunnel, where growth of the Campanula and Larkspur variety trials were adversely affected. Stem lengths were only half of normal, and yields were reduced to such an extent that the results of the latter two experiments will not be reported.

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 plot, and 2 replications in both the tunnel and outdoor variety trials.

Plots in the tunnel were irrigated weekly during most of the season 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.

ANEMONE RANUNCULUS TRIAL

A December2012 planting of anemone and ranunculus in the high tunnel was quite successful in producing substantial yields of stems in April and May. To determine if this result is reliable and not due to the winter conditions, the experiment was repeated a year later. We compared 2 varieties each of the two species, the use of secondary spun-bonded row cover, and the use of a pre-sprouting treatment as well. The companies that supply the planting materials recommend that the corms be pre-sprouted for 3 weeks in moist medium at 50 F before planting, but we theorized that the fluctuating soil temperature in the high tunnel could accomplish the same thing.

Materials and Methods: Anemone varieties Galilee Red and Marianne Blue, and ranunculus varieties Supergreens Red and Amadine Orange Picotee were soaked in warm water for 24 and 6 hours, respectively, starting on Dec. 4. The planting materials were sourced from Fred C. Gloeckner. Thereafter, half were directly planted in the high tunnel, and the rest were mixed in coarse, moist vermiculite for 3 weeks, and held at 50 degrees in a dark storage. The pre-sprouted corms were then planted in the tunnel on Dec. 23. Experimental design in the tunnel consisted of main plots of pre-soaking, sub-plots of low tunnel cover treatments and varieties as sub-subplots. There were 2 replications.

Results and Discussion: The low winter temperatures delayed the first harvest by about a week compared to the previous year, but the earliest treatments had open flowers by April 14 (Table 1).

The use of low tunnels hastened flowering by 11 days. The flowering of anemone 'Galilee Red' was especially stimulated by the tunnel cover (Table 1). Additional effects of covering were an increase in stem length, and a boost in the number of plants that emerged. Neither stem numbers per plant nor plant stand were affected by use of the tunnel cover, but yield per unit area tended to increase with low tunnel protection.

There were considerable differences in the species and variety responses to the treatments imposed. The ranunculus variety Amadine Orange Picotee had consistently longer stems and more of them, than the other varieties and species.

Table 1. The effect of a low tunnel cover over anemone and ranunculus planted in a high tunnel in December 2013 on stem length, stem yield and earliness of flowering.

Cover	Variety	Stem length, cm	Stems per plant	Flowering start, days	Plant stand, %	Yield, stems/ft^2
None	Anem. Galilee Red	26.1	3.3	150	86	11.0
None	Anem. Marianne Blue	22.3	3.2	164	70	8.9
None	Ranunc. Supergreens	25.2	3.8	158	79	9.4
None	Ranunc. Amadine	31.8	5.9	162	66	16.4
Cover	Anem. Galilee Red	28.5	4.0	134	95	15.4
Cover	Anem. Marianne Blue	21.7	4.0	150	94	15.0
Cover	Ranunc. Supergreens	31.2	3.8	150	88	13.3
Cover	Ranunc. Amadine	36.0	5.6	154	98	21.8
Interaction significance		**	ns	*	ns	ns
Low tunnel significance		*	ns	**	ns	ns(p=0.07)
Variety significance		***	***	***	ns	***

Pre-sprouting the corms in this experiment significantly reduced stand from 92 to 76%, and thereby reduced stem yield per unit area from 15 to 12.8 stems per ft^2. This effect was especially marked for both ranunculus varieties (Table 2). These results indicate the importance of keeping the newly planted pre-sprouted planting materials well hydrated during and just after the transplanting into the cold high tunnel. Even the addition of a low tunnel cover over these young delicate plants appears to aid survival.

Table 2. The effect of pre-sprouting the planting material for 3 weeks in 50F storage on stand in the tunnel, and yield per unit area.

Species	Variety	Stand, percent		Yield, stems/ft^2	
		Control	Pre-sprouted	Control	Pre-sprouted
Anemone	Galilee Red	94	88	11.2	15.2
	Marianne Blue	80	84	10.8	13.0
Ranunculus	Supergreens	98	69	14.4	8.4
	Amadine	98	66	23.8	14.4
Pre-sprout significance		***		*	
Interaction significance		**		***	

Fig. 3. Ranunculus 'Supergreens Red' in the high tunnel. Picture taken May 5, 2014.

Overall, the results of this experiment confirm the hardiness of anemone and ranunculus when overwintered in a high tunnel in a cold environment. Although slightly delayed in harvest date compared to the experiment conducted in milder conditions in the previous year, yields and stem lengths were comparable.

Table 3. Average stem length and yield per plant of two varieties of anemone and two of ranunculus, comparing the soaking of the planting stock for 3 weeks prior to planting in the high tunnel, and the use of low tunnels. Corm soaking was begun on Dec. 4, and the 'no soak' treatments were planted in the tunnel on Dec. 6; those soaked were planted on Dec. 23.

Species	Variety	No soak, no cover	No soak, cover	Soak, no cover	Soak, cover
		Stem length, cm			
Anemone	Galilee Red	24.1	29.2	28.2	27.8
	Marianne Blue	22.6	21.8	22.0	21.6
Ranunculus	Supergreen	27.0	30.2	23.4	32.3
	Amadine	32.2	37.0	31.3	35.0
		Yield, stems per plant			
Anemone	Galilee Red	2.6	3.0	2.9	4.7
	Marianne Blue	2.4	3.0	2.0	4.5
Ranunculus	Supergreen	3.2	4.0	1.6	2.6
	Amadine	5.8	6.1	2.4	4.8

			Flowering date		
Anemone	Galilee Red	April 28	April 20	May 8	April 14
	Marianne Blue	May 14	May 7	May 20	April 30
Ranunculus	Supergreen	May 9	May 2	May 12	May 4
	Amadine	May 13	May 9	May 16	May 6

SUNFLOWER PHOTOPERIOD REACTION TRIAL

We again tested the reaction of new cut flower sunflower varieties to daylength in the seedling stage. This requires that the new lines are exposed to either short or long daylength in the first 3 weeks after emergence, before being planted in the field, and the flowering date and plant and flower sizes are then noted.

Materials and Methods: Seeds for the study were sown in 72-cell trays in peat-vermiculite artificial soil mix, and placed on a daylength-controlled bench in a greenhouse, either at a 12-hour daylength as controlled by a mechanical blackout curtain, or in another part of the same bench in which daylength was extended with artificial light to 16 hrs. The daylength treatments were applied for three weeks after emergence, then the plants were transplanted in the field at 9 x 9 in. spacing, in two replications. Due to space restrictions on the greenhouse daylength bench, the two reps of the 19-variety trial were planted sequentially. The first planting was sown on May 14 and transplanted to the field on June 9; the second replication was sown June 11 and transplanted July 7. As in previous trials, 'Procut Lemon' was planted as a daylength neutral control, and 'Sunrich Orange' as a short day sensitive standard variety. Data on plant and main stem flower head characteristics were taken at anthesis of each flower.

Results and Discussion: A majority of lines tested this year were sensitive to daylength, exhibiting a short-day reaction (58%). Only one (Procut Red) showed a slight lengthening of days to flowering under short days, and 37% of the lines were daylength neutral (Tables 4, 5). As in previous years, varieties which showed a short-day reaction flowered earlier when given short days in the seedling stage, and plants were just half as tall, and had significantly smaller flowers (Tables 4, 5). The short day reaction was also accompanied by the appearance of flower buds on the upper nodes of the plant. A summary table on the reaction to daylength of all the varieties tested since we started to screen in 2006 can be found at my research page of the Horticulture Section faculty pages: (http://hort.cals.cornell.edu/sites/hort.cals.cornell.edu/files/shared/documents/Daylength-response-of-sunflowers.pdf). More details of the screening program's results through 2012 has recently been published in: HortTech. 24(5):575-579, 2014.

Table 4. Daylength reaction of sunflower varieties as indicated by time to flowering and plant height at flowering. Short (12 hours) and long (16 hours) daylength was imposed on seedlings during the first 3 weeks after emergence in seedling trays in a greenhouse, and plants were then transplanted to the field.

Name (Source)	Daylength reaction	Days to first flower		Plant height	
		Short day	Long day	Short day	Long day
Jua Inca (PanAmerican)	Neutral	56	62	103	124
Jua Maya	Neutral	56	60	105	122
Sunrich Summer Lemoncello (Takii)	Short day	48	66	47	97
Premier Orange	Short day	46	64	45	93
Sunrich Gold	Short day	54	74	78	129
Tiffany	Short day	50	79	76	166
Apricot Daisy (Harris)	Neutral	68	64	119	120
Procut Red	Long day	76	68	159	136
Tavor Orange Joy (Gloeckner)	Short day	53	67	59	119
Tavor Flash	Neutral	59	64	104	135
Tavor Double	Neutral	58	60	84	121
Vincent Fresh	Short day	54	62	90	119
Vincent Choice	Neutral	56	56	96	100
Sunrich Orange (Harris)	Short day	53	73	76	137
Procut Lemon (Seed Sense)	Neutral	62	60	107	102
TH 708	Short day	45	64	46	105
TH 709	Short day	46	64	42	87
TH 711	Short day	44	62	45	92
TH 713	Short day	48	72	63	145

Table 5. Summary table of three classes of response to daylength, showing averages for days to first flower, diameter of the flower at anthesis, and the number of flower buds in the upper four nodes of the main stem.

Daylength reaction class	No. of varieties	Days to first flower		Flower diameter, cm		Bud no.	
		Short day	Long day	Short day	Long day	Short day	Long day
Short day	11	49	68	3.6	6.2	2.6	0.4
Day-neutral	7	59	61	4.7	5.5	1.4	0.7
Long day	1	76	68	7	6	0	0

VARIETY DESCRIPTIONS:

The descriptions were taken on plants that had been given the seedling long-day treatment, to avoid the dwarfing effect of short day treatment on sensitive varieties.

1. **Jua Inca:** A bicolor of medium height and mid-season maturity. No buds on upper nodes, daylength neutral and promising.
2. **Jua Maya:** A standard orange flowered sister line to Jua Inca, similar in plant height and earliness. One of few daylength neutral standard orange varieties on the market.

3. **Sunrich Summer Lemoncello:** A mid-season single stem sunflower with light yellow petals and dark disk. Seedlings are strongly sensitive to short days.

4. **Premier Orange:** A mid-season standard variety with orange petals and dark disk. Seedlings are strongly sensitive to short days.
5. **Sunrich Gold:** Moderately late variety with large flowers and tall stems. Flower petals deep yellow with green-yellow centers. Strongly short day sensitive.

6. **Tiffany:** Late, tall variety with dark yellow petals and dark centers. Flowers have large disks and relatively short petals. Seedlings are strongly sensitive to short days.
7. **Apricot Daisy:** Medium height branching variety. Flowers distinctive, with long yellow pointed petals and yellow-green centers. Seedlings are day-neutral.
8. **Procut Red:** Late, tall plant with sturdy stem without leaf axle buds. Vase life ca. 5 days, compared to more than a week for other varieties in this trial. Tested slightly long-day sensitive this time, was insensitive to daylength in 2012 test.

9. **Tavor Joy Orange:** Moderately tall plant with standard orange petals and dark disk. Petals long and pointed. Seedlings strongly sensitive to short days. Variable bud production on stem.
10. **Tavor Flash:** Bicolor variety with medium sized heads on moderately tall plants. Insensitive to daylength in the seedling stage.
11. **Tavor Double:** Relatively early double flowering plants with some branching. Insensitive to daylength. Worth another trial.

12. **Vincent Fresh:** Relatively short and early flowering variety with small flowers and blunt pointed petals and yellow-green centers. Appeared to be slightly daylength-sensitive in this trial.

13. **Vincent Choice:** Similar in height and earliness to Vincent Fresh. Some appearance of buds on the upper stem. Tested day-neutral this time; was slightly short-day sensitive in 2012.

14. **Sunrich Orange:** Our standard short-day sensitive cultivar in all trials. Upward-facing medium-large head with orange petals and dark disk. Stem clean.

15. **Procut Lemon:** Standard daylength-insensitive variety. Midseason maturity, medium stem length with large head, light yellow petals and dark disk. Sturdy, clean stems.

16. **TH 708:** Standard orange variety with medium height and medium head size. Sensitive to short days in the seedling stage.
17. **TH 709:** Standard orange variety, shortest plants in the trial. Sensitive to short days in the seedling stage.
18. **TH 711:** Medium maturity and stem length, petal color dark yellow with green-yellow disk. Strongly sensitive to short days in seedling stage. Some buds on upper stem.

19. **TH 713:** Moderately late and tall variety with large head, dark yellow petals and green-yellow center. Stem smooth. Strongly sensitive to short days in the seedling stage.

DEFOLIATION OF PEPPERS WITH ETHEPHON

Pepper stems with mature fruits attached make attractive additions to fall bouquets, especially if those stems no longer have leaves attached. As we have seen in previous studies, *Capsicum annuum* lines tend to retain green leaves even as the fruits mature, so defoliation must be done manually or by use of chemical agents. To explore the latter possibility, we tried several rates of ethephon, the ethylene-releasing agent that is used for defoliation and fruit ripening in several vegetable crops.

Materials and Methods: The experiment was done with 2 pepper species: *C. baccatum* (PI 159252) and *C. annuum* (Rio Light Orange and Cappa Conic). These were seeded on April 1 in 98-cell trays in the greenhouse in artificial soil mix, and transplanted to the field on May 21. The experimental design was a split plot, with ethephon concentrations as main plots and species as subplots. Subplots consisted of 18 plants in 2 rows, 9 in. apart in the row. Since there was insufficient seed of *C. annuum* 'Rio Light Orange' for 3 reps, one replication used 'Cappa Conic' instead. On Sept. 17, when lowest fruits on the plants were turning to mature color, ethephon was sprayed on the plots at rates of 0, 100, 500 and 1000 ppm. When no discernible symptoms of foliage loss had occurred by Sept. 26, treatments were reapplied to the same plots using 5 times the initial rates.

Results and Discussion: Three days after the Sept. 26 application, leaf yellowing and loss of flower buds became noticeable in all varieties. By 5 days, most upper and middle leaves in the canopy had dropped as a result of the 5000 ppm application, especially in PI 159252. Moderate loss of mature fruits was also visible with this treatment and variety. Defoliation was less marked for the *C. annuum* lines, but there was increased reddening of mature fruits of 'Cappa Conic'. There was insufficient defoliation in the 2500 ppm application rate in both species.

Temperatures in the week after the ethephon was applied may have played a role in the efficacy of the chemical: after the Sept. 16 application, the mean temperature averaged 53 F, about 7 F below normal for that month. After the Sept. 26 application, a mean of 62 F was experienced, more effective for the chemical to work.

Stems bearing fruits were harvested on Oct. 3 and placed in water in a lighted storage room with temperatures in the low 60's, to determine if defoliation and fruit ripening would continue. After 2 weeks, defoliation did not progress beyond that seen in the plants in the field, but at the 2500 and 5000 ppm rates, fruit ripening was accelerated for both 'Cappa Conic' and 'PI 159252'. 'Rio Light Orange' did not develop red color in any of the treatments.

Please refer to the pepper variety trial below for more results of ethephon treatment, and overall conclusions on ethephon efficacy as a pepper defoliant.

PEPPER VARIETY TRIAL

In previous growing seasons, we have tested a number of pepper lines for their value as cut stems bearing mature fruits for fall bouquets. These results have shown that in general, *C. annuum* lines retain their leaves when stems are harvested, but these leaves wilt and become unsightly in the vase, even if given a hydrator treatment at harvest. The current trial extends this hydration work, and then tests the efficacy of a high rate of ethephon as a defoliant.

Materials and Methods: Six lines of *C. baccatum*, and 1 line and 6 named varieties of *C. annuum* were grown in the field in two replications. To prevent interference between accessions because of the larger stature of the *C. baccatum* materials, these were grouped separately from the *C. annuum* lines. The C. baccatum lines were spaced 18 x 12 in. apart in two rows; the *C. annuum* were spaced 12 x 12 in. in 3 rows. Each had 12 plants per plot and there were 2 replications. Seeds were sown on April 4 and transplanted to the field on May 23. On Sept. 19, 3 branches were harvested from each plot and were placed in either hydrator solution or plain water. After an initial 60 min. of hydrator exposure, stems were transferred to plain water. All stems were then stored in a storage room at temperatures in the mid-60's, and observed after 3, 7 and 14 days. An additional set of 3 stems per replication were harvested and stored dry until being evaluated for ease of defoliation and appearance about a month later. To gather information on the use of ethephon as a possible defoliant, a solution of 5000 ppm ethephon was applied as a foliar spray on Oct. 8 to Rep 1.

Results and Discussion: Vegetative growth of the plots was adversely affected after transplanting by the high soil pH, which caused initial stunting, especially amongst the *C. annuum* lines. The *C. baccatum* lines grew to nearly normal height and produced similar yields of stems as in 2013. Please check those results for quantitative information.

As a result of the variable growth in the plots, we concentrated on gathering data on postharvest characteristics (Table 6). As in 2013, the PI lines stayed hydrated well when harvested fresh, with leaves remaining turgid for at least a week. Placing the stems in hydrator solution for an hour before putting them in water improved their ability to stay hydrated. The named varieties wilted more rapidly, and were at least droopy after a week. Some, such as 'Cappa Topfruit' and 'Garda Tricolor' had dry leaves at the end of two weeks in the vase. Pretreatment with hydrator solution did not have an ameliorating effect on the named varieties.

The set of stems that were harvested and stored dry varied widely in the ease with which leaves could be removed after several weeks storage (Table 6). Leaves could be removed easily from PI 441542, whereas PI 159252 required considerable effort. With some lines, such as 'Cappa Topfruit', leaf removal was facilitated by the clustering of the leaves at the top of the plant. The attractiveness of the dried fruits on the stems varied among the varieties tested, as is shown.

Table 6. Hydration status of fresh pepper shoots after 3, 7 and 14 days in either water or in water after hydrator solution pretreatment, and ease of leaf removal and attractiveness after several weeks of dry storage of 13 ornamental pepper lines grown in the field.

Pepper line	Hydration evaluation[z]						Dry plant evaluation	
	3 days		7 days		14 days			
Hydration sol'n.	No	Yes	No	Yes	No	Yes	Leaf removal ease[y]	Attractiveness[x]
PI 159252	3	3.5	3.5	3.8	2.2	3.2	1	1.5
PI 441525	4	4	4	4	2.5	3.2	2	2
PI 441542	4	4	4	4	3.2	3.8	4	3.5
PI 441552	4	4	4	4	3.5	3.8	2	4
PI 441572	3.8	3.8	3.5	4	2	3	1.5	4
PI 441575	3.2	4	3.5	4	3	3.8	3	3.5
PI 193470	4	4	3.5	4	2.5	2.5	3	3
Cappa Topfruit White/Red	3.5	4	2.5	2.8	1.2	1.5	3	4
Garda Tricolor	4	4	2	2	1	1.5	1	1.5
Garda Chandelier	4	4	2.8	3.5	2	3	2.5	4
Orange Globe	3.5	4	2.5	3.2	2	1.8	1.5	3.5
Rio Yellow	2	3.8	2.2	3	2	2	2	3.5
Black Pearl	4	4	2.8	3.8	2.2	2.5	1	1.5

[z]Hydration evaluation: 1= wilted; 4= fully turgid

[y]Leaf removal ease: 1= difficult; 4= easy, partly defoliated

[x]Attractiveness: 1= ugly; 4= attractive, with prominent, well-colored fruits

The single spray of 5000 ppm ethephon, applied only to Rep. 1 on Oct. 8 resulted in drastic loss of both leaves and fruits, especially for the *C. baccatum* lines (Fig. 4). The response may have been accentuated by a light frost on Oct. 12, which singed the youngest leaves on the plants, and caused some leaf loss in the middle of the canopy, but did not cause fruit loss or affect fruit appearance. The response to ethephon may have been further accentuated by a period of warmer weather beginning 5 days after the application of the chemical. This exploratory investigation into techniques to remove leaves from maturing pepper plants illustrates the difficulty of using ethephon, which requires moderate temperatures to act, and whose effect can be modified with the occurrence of frost soon after application. Other means are needed that are less dependent on temperature conditions.

Fig. 4 . Leaf and fruit loss by pepper lines, 8 days after a foliar application of 5000 ppm ethephon.

VARIETY DESCRIPTIONS:

PI 159252: Plants 33 in. tall, broad, fruits 4 to 5 in. long, wrinkled, curved, yellow with purple blush on exposed side.

PI 441525: Plants 41 in. tall, with prominent yellow fruits on top of canopy, 3 x ¼ in. Very sensitive to ethephon, dried fruits blotchy and dull in color.

PI 441542: Plants 41 in. tall, with prominent small yellow fruits on top of canopy. Fruits 1.5 x ½ in., blunt ends. Attractive and showy when dry.

PI 441552: Plants 41 in. tall, broad, with round, slightly pointed fruits prominent on top of canopy. Fruits green turning to red, thick-walled, pungent. Fruits attractive when dry.

PI 441572: Plants broad, 33 in. tall with relatively thin branches. Fruits mostly in the canopy, pendent, green turning to red, bonnet-shaped, slightly pungent, 1.5 x 1.5 in. in size.

PI 441575: Plants broad, 33 to 41 in. high, fruits yellow with pink blush, pointed, 2 x ½ in. Very sensitive to ethephon.

PI 193470: Plants erect, 33 to 41 in. tall. Fruits erect, blunt pointed, 1 x ¾ in, green with purple blush, turning red. Plants moderately attractive dry.

Cappa Topfruit White/Red: Plants 21 in. tall, dark green leaves, fruits in clusters at top of canopy, pointed, 2 x ½ in., yellow ripening to orange, attractive dry.

Garda Tricolor: Plants only 5 in. tall, broad, with prominent, upright 1 x ½ in. size. Fruit color starts yellow, turns purple, then red. Attractive fresh, but ugly when stems are dry. Wilts rapidly in the vase.

Garda Chandelier: Plants 21 in. tall, fruits showy, upright pointed, yellow, 2 x ½ in. Stems showy dry, and leaves stay turgid in vase for one week after hydrator treatment.

Orange Globe: Plants 21 in. tall, fruits round, ¾ in. diameter, borne in clusters at top of plant; fruits green turning orange.

Rio Yellow: Plant height varies from 14 to 21 in. Fruits upright, round, ¾ in diameter, green turning yellow.

Black Pearl: Plants 21 in. tall, dark purple stems and leaves and fruits. Fruits in clusters, shiny ¾ in. diameter, egg-shaped. Attractive fresh, and stays hydrated for a week with hydrator treatment. Unattractive when dried.

LISIANTHUS SPACING AND TOPPING TRIAL

The tiny seed size and long, slow seedling growth period of lisianthus has encouraged growers of this crop to purchase seedlings produced by commercial propagators. Since these ‘plugs’ appear to be expensive, we were interested to know if stem yields of the crop can be increased by varying plant spacing, combined with pinching of the main stem to stimulate branching.

Materials and Methods: Seedlings of lisianthus were purchased from the commercial plant propagator 'Grow-N-Sell'. The seedling plugs were in 216-count trays, arrived on May 15, and were transplanted into 72-count trays in Cornell mix artificial soil. These were allowed to grow until June 4 in the greenhouse, and were then transplanted to the field in four replications. Another 2 reps were planted in the high tunnel on June 18. Treatments in both locations consisted of the varieties 'ABC 1-3 Purple' and 'ABC 1-3 White', spacing of the plants in the field/tunnel at either 9 x 9 in. spacing with 4 rows per bed, or 6 x 6 in. with 6 rows per bed. When the transplants reached the 6 extended leaves stage, they were pinched leaving about 4 nodes, or not pinched. The experimental design in both field and tunnel was a split plot, with spacing as main plots, and varieties and pinching treatments as subplots. In late September harvested stems that had only an open flower and no flower buds were identified and designated as less desirable. Statistical analysis of the date was done using JMP software, combining the results from both locations.

Results and Discussion: The combination of the results from field and the high tunnel allowed us to measure the effects of the treatments with great precision. Stem length was not affected by spacing, but was increased 8% by topping. That increase was more marked at the closer spacing, leading to a significant interaction (Table 7). Flowering time was delayed by 6 days due to the topping treatment, and by one day at the closer spacing. Spacing and topping both increased stem yield per unit area, but the two combined had the most positive effect, boosting the no. of stems per ft^2 by 80%. Plants produced stems without buds in all treatments, but the frequency of occurrence caused only a slight decrease in net yield.

The two varieties responded similarly to the treatments imposed, with the purple two days earlier to flower, producing longer stems and responding more to the closer spacing (Table 8).

Table 7. Stem length, time of flowering and yield per unit area for two varieties of lisianthus grown both in the field and in the high tunnel. Net yield was calculated by eliminating stems that has only an open flower and no buds.

Treatment	Levels	Stem length, cm	Stems per ft^2, total	Stems/ft^2, net	Days to flower, (from Jan. 1)
Spacing	9 x 9 in.	40.3	8.9	8.7	218
	6 x 6 in.	39.8	13.5	13.1	219
	Stat. signif.	ns	***	***	*
Topping	None	38.5	10.0	9.6	215
	Topped	41.6	12.4	12.2	221
	Stat. signif.	***	***	***	***
Spacing x Topping	9 x 9 no	39.6	8.6	8.4	215
	9 x 9 yes	40.9	9.3	9.1	220
	6 x 6 no	37.3	11.5	10.9	216
	6 x 6 yes	42.3	15.5	15.2	222
	Interact. signif.	**	***	***	ns

Table 8. Stem length, yield per unit area and earliness of flowering for two varieties of lisianthus, as influenced by spacing in the bed, combining the results of both field and high tunnel plantings.

Treatment	Levels	Stem length, cm	Stems per ft^2, total	Stems/ft^2, net	Days to flower, (from Jan. 1)
Variety	ABC Purple	41.8	11.6	11.2	217
	ABC White	38.3	10.9	10.6	219
	Stat. signif.	***	*	ns	***
Spacing x Variety	9 x 9 Purple	41.8	9.0	8.7	217
	9 x 9 White	38.8	8.9	8.8	218
	6 x 6 Purple	41.8	14.2	13.6	218
	6 x 6 White	37.8	12.9	12.5	220
	Interact. signif.	ns	*	*	ns

Although one would expect the tunnel plantings to come into flower first, in this instance the two-week delay in establishing the tunnel planting resulted in identical flowering dates. There were slight (15%) yield increases in the high tunnel due to the prolonged fall harvest, and stems also tended to be slightly (16%) longer in the tunnel. We have seen similar trends in previous years.

The results of this trial indicate that lisanthus can be considerably more crowded in the bed in both tunnel and field, and significantly improve yields without hurting flower quality. The crowding can be achieved both by closer plant spacing as well as early topping to induce more stems to form on each plant.

Fig. 5. Lisianthus planting in the high tunnel (left) and in the field.

CELOSIA COMB DEFORMATION TRIAL

When *Celosia cristata* is grown in field or greenhouse in the Ithaca area, the flower often does not form an attractive 'cock's comb', but becomes malformed. This occurs with several varieties, but we have never tried to determine the causal factor(s). In the literature there is indication that exposure to long daylength can increase the degree of fasciation of cock's comb, but the appearance of this disorder is not so regular to make daylength a likely causal factor. Since temperature often fluctuates widely under our field and high tunnel conditions, and since many *C. cristata* varieties were developed for the less fluctuating conditions of a greenhouse, temperature as a causal factor seemed worth checking.

Materials and Methods: The variety Bombay Sunshine (PanAmerican) was used in all plantings. Seeds were sown in 128-cell trays in artificial soil mix, and seedlings produced at 70 F in the greenhouse. At 2 to 4 weeks after sowing, seedlings were transplanted into 4 in. pots in artificial mix, and placed either in a growth chamber set at 60 F day and 50 F night temperature on a 12-hour photoperiod, or in the greenhouse set at 72 F with natural daylength. Pots were left in the cool growth chamber for either one or two weeks, and then transferred back to the greenhouse. Cool treatments began at transplanting to the pots, or a week later, and lasted either one or two weeks. Growing points of sample plants were examined at the time of cool treatment to determine if the flowering meristem had already formed. The experiment was conducted 3 times, with sowing dates of March 27, April 21 and May 19. There were 15 pots per treatment. After the conclusion of the temperature treatments of all the treatments in each run, six remaining pots from each treatment were planted in the high tunnel until the combs were in full flower, and the comb structure examined.

Results and Discussion: The growing point of this variety of cockscomb celosia shows as a rounded, indistinct dome when still producing leaves. When the flower forms at the plant apex, it changes to a distinct rectangular spade structure when becoming reproductive. We managed to transfer the pots to the cool environment just during that transition in the first and third plantings (Fig. 6), but the apices were past that transition in planting 2.

Fig. 6. Comb appearance of 'Sunshine' celosia when grown under 72 F conditions in a greenhouse (left),or given 2 weeks at 60/50 F at the point of growing point transformation to flower formation.

Images are from the first planting.

Pots that were transferred to the cool environment a week later were not altered in appearance of the comb. In the second planting, the cool treatment did not start until the apical meristem had been transformed to a reproductive structure, and only some basal secondary comb formation occurred in the early cool treatment (Fig. 7).

Fig. 7. Comb appearance of 'Sunshine' celosia after the second planting's treatments.

In the third planting, we transferred the seedlings to pots 14 days after sowing, when the apical meristems were still producing leaves. The results of the cool treatment on the morphology of the comb were difficult to understand. In this experiment, all the treatments produced combs that were malformed (Fig. 8) regardless of temperature treatment. The nature of the distortion was different than in Planting 1: the upper part of the comb was divided into extended comblets. Since this change in comb shape occurred in all treatments, another event common to all treatments must have over-ridden the temperature effects imposed. More work is needed to better understand the factors influencing comb shape in celosia.

Fig. 8. Comb shape after cool temperature treatment in the third planting.

OVERWINTERING SNAPDRAGONS IN THE HIGH TUNNEL

In fall of 2013, we conducted a snapdragon variety trial with 7 varieties in the high tunnel. As temperatures decreased and the plants stopped producing, the foliage appeared still to be healthy and vigorous, so we decided to keep the trial until Spring 2014 to see if the plants would resume growth and produce an early yield. The findings were summarized in an ASCFG Quarterly article in the Summer 2014 issue:

OVERWINTER SNAPS IN THE HIGH TUNNEL

H. Chris Wien, Dept. of Horticulture, Cornell University, Ithaca, NY

Snapdragons are usually an early summer crop, with first harvests in mid-June in our Zone 5 climate. In this past year, we happened upon a painless way of advancing harvest by a month.

We planted a fall crop of seven varieties in our high tunnel, sowing the seeds on June 4, and transplanting into the tunnel on July 15. In the high tunnel conditions of mid-summer, the first flowers are usually too small to be useful, so we pinched out the main stem at transplanting.

Harvest began in late August, and continued into late October. Yields varied from 7 to 13 stems per plant at the 9 x 9 in. spacing (see Table). We provided no special protection over winter, and expected to uproot the plants in time for the spring planting season. But in spite of the harsh winter conditions that we experienced in the Northeast this year (January through March temperatures outside averaged 20 F, 7 F below the long-term average), stems on many plants remained green and they resprouted at the base in March. Plants made vigorous growth, and we are actively harvesting now (at end of May).

Winter survival was, however, quite variable, with the early varieties (Maturity groups 1 and 2) having higher mortality than the later types (see Table). Winter survival appeared to be lower for the higher-yielding early varieties, perhaps because flower production reduced their storage reserves and made them more susceptible to winter injury. That theory will need to be tested in future trials.

The concept of summer-planting snapdragons for fall and then spring harvest in a high tunnel is worth exploring further, and might be enhanced by providing additional winter protection by use of low tunnels or a thick layer of straw mulch. Give it a try!

Variety (Source)	Maturity group	Stems per plant, 2013	First harvest (DAS)[z]	Winter survival, %
Chantilly Velvet (Takii)	1-2	13	78	63
Purple Twist (PanAmer.)	2	10	83	8
Trumpet Pink	1-2	11	81	44
Madame Butterfly Mix (Geo)	3-4 (?)	6	93	72

Snappy Tongue	3-4 (?)	8	88	80
Supreme Light Lavender (Gloeckner)	2-3	7	85	66
Potomac Lavender (PanAmer.)	3-4	7	94	98

[z]First harvest time in late summer/fall 2013, in days from sowing

Thanks to Liza White and Priscilla Thompson for valuable technical help. For a more complete summary of our 2013 trials, visit http://blogs.cornell.edu/hort/2014/03/02/2013-cut-flower-trial-report/

Fig. 9. Snapdragon trial on May 28, 2014. Note also the Eucomis lily trial in the adjacent row.

By the end of the spring harvest, plants had produced nearly 80 % more yield on an area basis (Table 9). Stem lengths were similar to those harvested in fall. The difference in harvest dates that we would normally expect in a spring planting did not occur with this regrowth. In 2013, our field planting of the same varieties ranged from June 8 for Chantilly Velvet to June 28 for Potomac Lavender. The regrowth in this trial began flowering in the last week of May for almost all the varieties.

As stated in the article, a fall high tunnel planting of snapdragons that is over-wintered produces considerable additional yield, and provides those flowers 3 weeks earlier than a spring-planted crop, without the labor and expense of spring seedling production and transplanting. This technique deserves more attention. The fall harvest results of an overwinter trial established in 2014 is reported below.

Table 9. Plant heights, stem yields per unit area and spring flowering date of seven snapdragon varieties planted in fall 2013 and allowed to overwinter. Plots were harvested in both fall and spring.

Variety (Source)	Stem length, cm		Stems/ft^2			DFF
	Fall	Spring	Fall	Spring	Total	Spring
Chantilly Velvet (Takii)	50	50	22.6	16.4	39.0	May 24
Purple Twist (PanAmerican)	50	52	17.4	1.2	18.6	May 28
Trumpet Pink	53	54	19.4	9.9	29.3	June 1
Madame Butterfly Mix (Geo)	63	63	10.0	15.1	25.1	June 1
Snappy Tongue	56	53	14.3	18.6	32.9	May 28
Supreme Light Lavender (Gloeckner)	53	51	12.8	10.1	22.9	May 27
Potomac Lavender (PanAmerican)	84	67	12.5	15.5	28.0	May 28
Average	58	56	15.6	12.4	28.0	

SNAPDRAGON OVERWINTER TRIAL, 2014-2015

With the indications from 2014 that many snapdragon varieties can be overwintered in the high tunnel, we designed an experiment to check this finding further. The varieties Maryland White (Group 2) and Supreme Light Lavender (Groups 2-3) were sown in the greenhouse on June 3 and July 3 and transplanted to the tunnel about 5 weeks later. Plants were topped at transplanting and spaced at 9 x 9 in. in 4 rows. Half the plots will be covered with a low tunnel over winter, and the survival of plants and their productivity measured. Fall harvests were good, with yields of about 16 stems per ft^2 for the first planting, and about half that for the second (Table 10). Harvests began in late August for Planting 1, and a month later for Planting 2, with 'Supreme Light Lavender' 2-4 days later than 'Maryland White'. The low tunnel covers will consist of medium weight non-woven fabric, and will be put up when weather conditions are consistently cold (presumably in mid-December).

Table 10. Fall 2014 harvest data for two varieties of snapdragons planted in a high tunnel from sowings in early June and July.

Planting	Variety	Stem length, cm	Stems/plant	Stems/ft^2	Days to first flower
June 3	Supreme LL	55	10.4	18.5	79
	Maryland	49	8.4	14.9	80
July 3	Supreme LL	57	6.2	11.0	84
	Maryland	52	4.9	8.6	88
Statistical signif.	Planting date	ns	ns	ns	**
	Variety	***	***	***	***
	Interaction	ns	ns	ns	ns

DELPHINIUM LONGEVITY TRIAL

Maintaining the plant stand of delphinium varieties for more than one year has been a difficult task, but there are marked varietal differences in this characteristic. The trial we started in 2013 illustrates the problem well. Plant stand for some varieties, notably Candle Blue and Guardian Blue, started to decrease in Fall 2013, and continued to decline into 2014 (Fig. 10). As can be seen in the 2013 Annual Report, the trial was established from seed on March 11, 2013, transplanted to the field in 3 replications at 12 x 12 in. spacing, and harvested during the 2013 season.

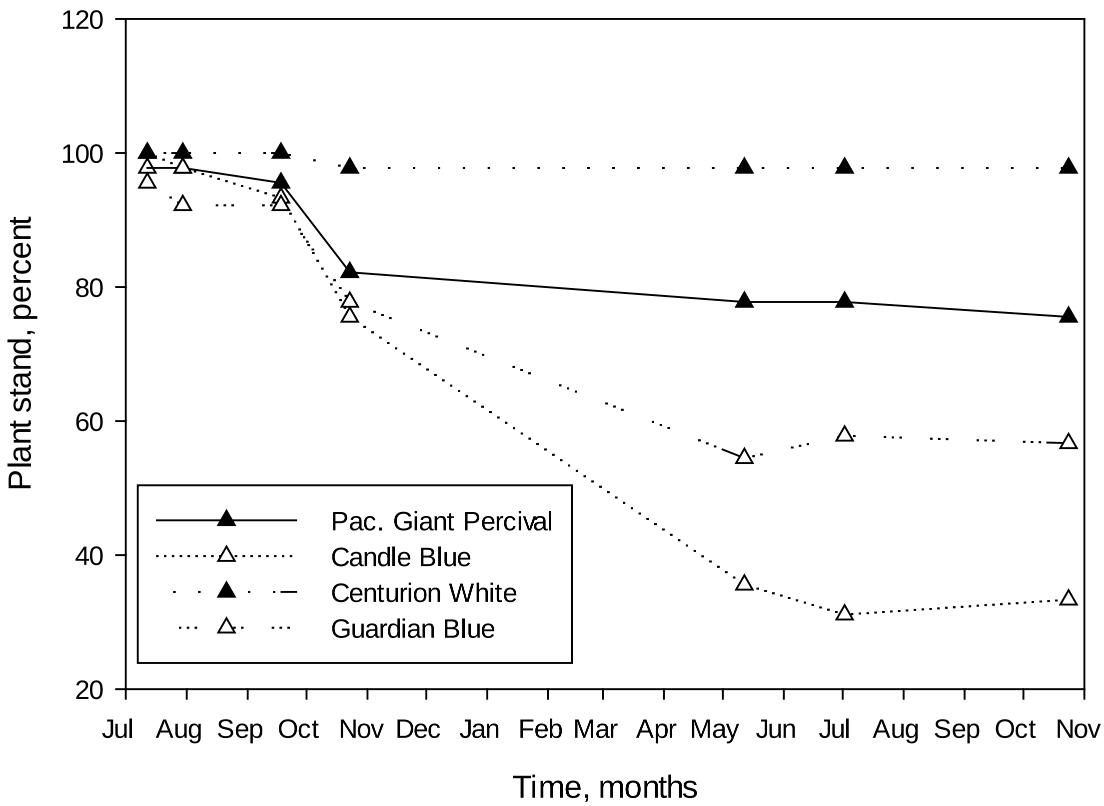

Fig. 10. Percent plant stand over time of a delphinium variety trial planted in the field May 15, 2013.

No special ground cover was applied to the trial over winter, and harvests continued through the 2014 growing season. Plant stand continued to decline through the 2014 growing season, so that by the end, 'Candle Blue' and 'Pacific Giant King Arthur' had less than half of the plants surviving, and' Guardian Blue' and 'Aurora Blue' were also fading (Table 11). With such low stands, yield per unit area became more important than yield per plant. The two 'Centurion' lines and 'Pacific Giant Percival' stood out in yield and stem length in the trial.

Table 11. Plant stand at the end of the 2014 growing season, stem length and yield of stems per plant and per unit area for 2014 for the delphinium variety trial established in the field in 2013. Means within a column followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test.

Variety	Plant stand, %	Stem length, cm	Stems/plant	Yield/ft^2, stems
Centurion White	98a	86a	7.6b	7.5ab
Centurion Rose	93a	81b	10.4b	9.7a
Aurora Blue	53b	59d	8.0b	3.8bc
Pacific Giant Percival	78ab	68c	13.2ab	9.8a
Candle Blue	31c	56d	19.2a	5.3b
Guardian Blue	58b	56d	10.7b	6.2b
Pacific Giant King Arthur	22c	54d	8.2b	1.9c

CUT FLOWER VARIETY TRIALS

ORNAMENTAL ALLIUMS

Early in the cut flower season, we frequently lack attractive and long-stemmed cut flowers that last in the vase. This role might be satisfied by the ornamental Alliums, grown from bulbs and hopefully becoming perennial in the landscape. Accordingly, we planted a small trial of several species in fall 2013, and observed their performance in 2014, with the intention of continuing the observations in succeeding years.

Materials and Methods: Six *Allium* species having large bulbs, and five with small bulbs were purchased from John Scheepers, Inc. and planted on Oct. 2, 2013. Those having large bulbs were spaced 12 x 12 in. apart, with 9 bulbs per plot; the small-bulb species were spaced 6 x 6 in. apart, with 24 bulbs in Rep. 1 and 12 in Rep.2, because of space restrictions.

Results and Discussion: Observations on the harvested flowers are given below (Table 12). Of the varieties planted, A. 'Silver Spring' was damaged by early spring frosts and A. cowanii did not emerge.

Table 12. Stem length, yield and flowering date of nine Allium species grown in the field in 2013.

Allium species	Stem length, cm	Stems per plant	Flowering date
1. A. aflatunense	64	1.2	May 18
2. A. albopilosum	30	1.0	June 10
3. *A. jesdianum* White Empress	89	0.9	May 23
4. A. multibulbosum	55	1.0	June 11
5. *A. stipitatum* Mount Everest	97	1.0	May 28
6. *A. amplectens* Graceful Beauty	25	2.0	June 11
7. A. azureum	35	2.0	June 22

8. A. Hair	58	0.9	June 17
9. A. sphaerocephalon	64	1.2	July 9

1. *Allium aflatunense*: Tall, early flowering dark pink to purple balls of 3 to 4 in. dia.; attractive.
2. A. albopilosum: Short plant with dark green leaves and 8 to 10 in. broad head.
3. A. jesdianum White Empress: Tall, white globe 4 to 6 in. diameter
4. A. multibulbosum: White globes of 3 to 4 in. size, mid-season flowering
5. A. stipitatum Mount Everest: Tallest flowers in the trial; large globes and thick sturdy stems.
6. *A. amplectens* Graceful Beauty: Relatively small plants with several flowering heads per plant. White balls 3 in. diameter.
7. *A. azureum*: Thin, delicate stems topped with dark blue balls of flowers, 1 to 2 in. dia. Late flowering.
8. *A*. Hair: Tall, thin erect leaves and stems topped with a ball of green tendrils, dark bulbils on stalks and buds. After flowering foliage died back, but started to sprout again in September.
9. *A. sphaerocephalon*: latest variety to flower; plants topped with a tight, ovoid sphere. Buds dark purple, open into dense 2 in. dia. spheres.

Fig. 11. *A. multibulbosum* and *Ornithogalum magnum* (left), and A. Graceful Beauty and Anemone (right)

AMMI

Mixed arrangements frequently are enhanced by the addition of a white filler flower that sets off the other species. *Ammi* and other species like it are often used for this purpose, so we decided to compare performance of six accessions.

Materials and Methods: The trial was sown in 98-cell trays on April 7, and transplanted to the field on May 21. Plants were spaced in 3 rows 12 in. apart, with 18 plants per plot. There were 2 replications except for *Orlaya*, which was unreplicated.

Results and Discussion: The plants in this trial grew well and were productive to the point of annoyance. It also became apparent during the harvesting that the two *Ammi majus* lines were nearly identical, giving very similar yields at about the same time (Table 13). These produced relatively open inflorescences, in contrast to the later lines. Similarly, *Ammi* Mystique and A. Green Mist were also very alike, but later than the *A. majus*. A grower thus could choose one in each pair, and fill their need for *Ammi* from middle of June to the end of August. A second planting of an early line could then fill out the season.

Tanacetum was lowest-yielding in the trial, and with relatively short, leafy stems. *Orlaya* produced a huge yield of short, attractive stems in mid-season. It also produced less of the dusting of abscised stamens that is a feature of *Ammi* in the vase.

Table 13. Stem length, stem yield and relative earliness of four *Ammi* accessions and two related species.

Species and variety	Stem length, cm	Stems/plant	Days to flower
Ammi majus White Dill (Johnny's)	38	28	78
Ammi majus Queen of Africa (Gloeckner)	36	28	76
Ammi Mystique (Harris)	44	28	112
Ammi visnaga Green Mist (Johnny's)	46	27	114
Tanacetum Crown White (Harris)	35	13	112
Orlaya White Finch (Johnny's)	34	53	88

Fig. 12. Priscilla and Anna harvesting the Ammi trial (left, with A. White Dill in foreground). *Orlaya* 'White Finch' (right).

Fig. 13. *Tanacetum* in flower (left) and *Ammi* 'Green Mist' (right).

CELOSIA

Materials and Methods: The seeds for the experiment were sown on April 21 in 72-cell trays in LM-1 fresh mix in the greenhouse, and transplanted on 25 May into the field. Spacing in the field was 9 x 9 in., with 24 seedlings per plot.

Results and Discussion: Growth was generally good, except that 'Sylphid' suffered some plant loss due to high incidence of a lower stem rot in both replications. Most varieties produced harvestable yields by the first week in July, and continued until frost (Table 14).

Table 14. Stem length, stem yield and flowering time of five varieties of plume celosia, grown in the field.

Variety	Stem length, cm	Stems/plant	Days to flower
Celway Red (Kieft)	42	19.4	79
Celway White	44	23.9	77
Sunday Yellow (PanAmerican)	46	18.6	72
Eternity Improved (Johnny's)	42	16.0	81
Sylphid	48	21.9	81

Celway Red: Bright red branching compact plume on dark red stems and foliage. Flower shape not especially attractive in arrangements. Variety had average productivity and stem length for the trial.

Celway White: Pale green, compact branching plume. Leaves and stems also light green. The most productive variety in the trial, of average stem length and earliness. Globular plume shape is not attractive.

Sunday Yellow: Thin, erect stems with prominent orange plume. Branches low on the plant, not near the head. Attractive.

Eternity Improved: Bright red compact plume on dark green foliage. Attractive and striking. Productivity is lowest in the trial.

Sylphid: Pale green foliage and bright pale green open plume. Plants and stems tallest in the trial. Aside from plant loss mentioned above, hydration in the vase was difficult, and vase life suffered as a result. This was the only variety that showed this problem.

COSMOS

Materials and Methods: Seeds for the trial were sown in LM 111 mix on May 5, and transplanted to the field on May 25. Field spacing was 12 x 12 in., with 18 plants per plot. Flower harvests started early to mid-July, and continued until frost.

Results and Discussion: Growth of the plants was vigorous, and good yields were obtained (Table 15). In mid-August, a severe outbreak of powdery mildew first affected 'Double Click Rose Bonbon' in both replications and later affected the other varieties in the trial, but less severely.

Table 15. Stem length, stem yield and time to beginning of flowering for four cosmos varieties grown in the field.

Variety	Stem length, cm	Stems/plant	Days to flower
C. bipinnatus Fizzy Formula Mix (Geo)	64	32	73
C. Bipinnatus Fizzy Rose Picotee	72	37	62
Picotee (Harris)	75	30	67
Double Click Rose Bonbon	60	32	74

Fizzy Formula Mix: Vigorous plants 4 ft. tall, with relatively leafy growth with few flowers. Flower size moderate, varied in color from purple to white, from single to semi-double.

Fizzy Rose Picotee: Plants similar to the mix, flowers relatively small, light purple with dark purple petal edges, semi-double.

Picotee: Plant size similar to above; flower size medium, varying in color from white to mid-purple with purple petal edges.

Double Click Rose Bonbon: Shortest plants and stems in trial. Cone-formed petals making them appear double.

DELPHINIUM

A supplementary variety trial was established at the north end of Rep. 3 of the other trial. As noted above in the general methods section, high pH of the seedling growth media caused loss of plants and stunting of the seedlings, so it was not possible to plant a full 3 replications in the field. Spacing was 12 x 12 in., with a maximum of 12 seedlings per plot. Varieties 1 and 2 had full plantings, variety 3 was planted in only two reps., and variety 4 in only the first rep.

Results and Discussion: With the stunting in the seedling stage, and possible unfavorable pH effects in the field, growth of this trial was weak and stem length quite marginal (Table 16). The first two varieties were a 'spray' types, with many short, thin-stemmed shoots and small florets. The second two lines were similar to those in the other delphinium trial, with longer spikes of flowers. Performance of none of the lines was noteworthy.

Table 16. Supplementary delphinium variety trial results in terms of stem length, stem yield and flowering date.

Variety	Stem length, cm	Stems/plant	Days to flower
D. grandiflorum Light Blue (Sakata)	26	11.2	112
D. grandiflorum Light Pink	25	10	114
D. elatum Candle Blue Shades	43	4.5	115
D. cultorum Magic Fountain Pure White (Geo)	57	4.2	118

EUCOMIS

Some of our findings with the pineapple lily (Eucomis) have been summarized in a Cut Flower Quarterly article for the Fall 2014 issue that is reproduced here:

CORNELL-COPIA FOR FALL, 2014

EUCOMIS LILY: OPPORTUNITY OR FLASH-IN-THE-PAN FOR GROWERS IN ZONE 5?

Chris Wien, Bill Miller and Shawn Lyons, Cornell University

The regal columns of the pineapple lily flowers *(Eucomis)* are impressive at first glance and confirm that impression with a vase life of nearly a month. Interest in this flower seems justified for milder regions, in which the crop can be grown as a perennial in the field, but does it make sense in the cooler parts, where winter survival is trickier? Our experience with *Eucomis* in Ithaca, NY (Zone 5b) may help answer this question.

The pineapple lily originated in the Drakensberg Mountains of South Africa, and has been selected and improved by plant breeders in New Zealand and other locations to produce stems long enough for cut flowers. They are classed for winter hardiness zone 7, but since the overwintering structure is its bulb, surface mulching can improve its chances of survival. We found that potted plants transplanted to the field in early September, 2013, only survived if mulched with 2 in. of wood chips, compared to being placed in unmulched bare soil. At another site near campus, a mulch-covered *Eucomis* planting continues to thrive after two winters.

A more reliable way to keep them alive in Zone 5 is to grow them in a high tunnel (unheated, clear-plastic covered greenhouse). Our oldest plantings of *Eucomis* are now 3 years old, and have grown vigorously over that period. However, less than half of the bulbs planted originally (from commercial sources) produced flowers in the first year. Yields and stem length have increased each season (Table 17), but the planting is now so crowded with plants that we worry about continued productivity (Fig. 14). The crowding comes from the fact that the original mother bulbs have produced a ring of tightly-attached daughter bulbs, each of which has its own set of leaves (Fig. 15). This thicket of leaves collapsed by mid-August this year, and may reduce the ability to resupply nutrients to the overwintering bulb. We will deliberately leave one very crowded planting until next year, to determine detrimental effects.

Another consideration for the *Eucomis* crop is its very concentrated flowering period. Our tunnel crops were harvested in 9 to 14 days in the 2013 and 2014 harvest seasons, a prohibitively short marketing period, especially for a crop largely unknown by the general public. Field-grown *Eucomis* crops lengthen the market window by flowering a month after the tunnel crop, so having both would seem like a good strategy.

These uncertainties about winter hardiness, plant spacing needed for long-term productivity, and a short market window may slow adoption of the pineapple lily as a cut flower crop in Region 5. It may thus be wise to try *Eucomis* on a small scale initially.

Fig. 14 (right) . Foliage of *Eucomis* lily planted in April 2012 at 12 x 12 in. *spacing in the high tunnel, matted down in August, 2014*

Fig. 15 (right). Bulb cluster of 'Reuben' *Eucomis* lily, when harvested in fall 2013 after April 2012 planting in our high tunnel.

Table 17. Yield and stem length of four pineapple lily varieties over 3 years planted in a high tunnel in April 2012 at 12 x 12 in. spacing.

Variety	Yield, stems per plant			Stem length, cm		
	2012	2013	2014	2012	2013	2014
Reuben	0.4	1.0	3.3	42	66	65
Innocence	0.1	2.7	3.9	55	73	73
Tugela Jade	0.1	2.2	3.3	43	66	66
Megaru	0.1	2.0	4.1	50	70	73

The second experiment that was planted in the high tunnel in April 2013 at 12 x 12 in. spacing survived the winter well and showed a similar increase in yield as the 4-variety trial shown above (Table 18). Stem length increased by 37% over 2013, but the time and duration of harvest remained the same.

Table 18. Yield , stem length and harvest duration of three Eucomis varieties planted in the high tunnel in April 2013 and harvested in 2013 and 2014.

Variety	Yield, stems per plant		Stem length, cm		Harvest duration	
	2013	2014	2013	2014	2013	2014
Tugela Gem	0.7	2.6	42	59	7/25-8/4	7/28-8/4
Tugela Jewel	0.6	3.7	50	69	7/26-8/6	7/26-8/5
Tugela Ruby	0.6	3.4	46	61	7/24-8/4	7/23-8/1

The first replication of the 2012 high tunnel planting was dug up in Fall 2013, and the bulbs stored over the winter in a 50 F storage room. In April 2014, bulbs were divided into 15 individual bulbs and their circumference measured before replanting in the same bed in the tunnel. All the bulbs grew new plants, but only some of these flowered (Table 19). Bulb size in the sample planted ranged from 9 to 27cm, but within each variety, size variation was more limited. Overall, the smallest bulb size for flowering was 15cm, but appeared to be larger for 'Reuben'. This experiment should be repeated with a larger number of bulbs of each variety to get a more comprehensive measure of the relation of bulb size and flowering.

Table 19. Influence of bulb circumference on production of flowers and flowering percentage for 15 indiviual bulbs planted in the high tunnel in April 2014.

	Bulb size (circumference)				
Variety	Plants flowering	Plants not flowering	Smallest size flowering	Size range	Flowering, percent
Reuben	25±2	13±2	24	11-27	27
Innocence	16±1	12.5±3	15	9-18	27
Tugela Jade	16±0.5	14±3	15	10-19	33
Megaru	21±4	15±1.5	15	13-26	67

The winter of 2013-14 was a good test of the winter hardiness of Eucomis bulbs. In a controlled experiment, we compared survival of three varieties in the field. Plants grown in 6-in. pots in the greenhouse until September 2013 were transplanted to our field and either mulched with 2 in. of wood chips, or only covered with soil. There were two replications, with plant numbers ranging from 6 to 12 per plot.

The results were quite clear with regard to the need for mulching: none of the plants that were not mulched survived the winter, and among those that had been mulched, the survival percentage varied from 17 to 42% (Table 20). There was considerable variation between the 2 replications, so the varietal differences may not be clear.

Table 20. Results of an overwintering experiment with three varieties of Eucomis, planted in the field in September 2013.

Variety	Plants per plot	Survival %	Flowering %
Reuben	6	17	0
Coco	12	42	21
Megaru	9	28	17

A second, unreplicated planting of 9 bulbs of the varieties in Table 17 was made in the field in Spring 2013 and also not mulched over winter. None of these bulbs survived the winter. To be sure to have some winter survival under Ithaca field conditions, a heavier layer of mulch is advisable.

FILLER SPECIES

Fillers fulfill an important role of providing body to cut flower bouquets. They may be species that furnish attractive leaves or flowers, and will hopefully be available for much of the harvest season of other cut flowers.

Materials and Methods: The trial compared the performance of four species and 7 entries. *Bupleurum* and *Eucalyptus* were sown on March 11, and the other species on April 2, all in 72-count trays. On May 12, the trials were planted to field and high tunnel at 12 x 12 in. spacing, with 15 plants per entry per plot if the available plant numbers allowed it. Both *Atriplex* lines (Vars. 6 and 7) had poor germination in the seedbox, resulting only 9 and 3 plants for A. 'Green Plume' and A. Red Plume', respectively in Rep. 1, and none in Rep. 2.

Results and Discussion: The species tested varied widely in the time that they could be harvested and their productivity (Table 21). Since the species are so different, they will be described individually below.

1. ***Bupleurum* Green Gold:** Bright green bilateral foliage with tiny green flowers. Plants and stems stayed short in both locations. Apparently growers plant in fall to get more vegetative growth before harvest.
2. ***Eucalyptus* Silver Drop:** Blue-green round leaflets of ¾ in. diameter on long thin stems. Attractive and long-lasting in the vase. Could be harvested from early September until frost, more productive in the field than in the tunnel. Little scent.
3. ***Eucalyptus* Silver Dollar:** Similar in stature and appearance to #2, but leaflets 1 – 2 in. diameter. Coarser appearance and some find the scent objectionable.
4. ***Euphorbia* Mountain Snow:** Attractive bright green fleshy leaves with tiny white flowers and white leaf borders. Plants flowered early, and should perhaps have been topped to encourage more vegetative growth before flowering. Promising when properly grown.
5. ***Gypsophila* Covent Garden:** Very early flowering delicate plant with thin stems and small white flowers. Did not maintain productivity through the season.
6. ***Atriplex* Green Plume:** Very low germination and therefore poor stand in field and tunnel. Tall erect stems that are too reminiscent of Lamb's Quarters in the vegetative state to be attractive. If left to produce seed heads, the stems become more attractive with disk-shaped pods of ca. 1/8 in. diameter.
7. ***Atriplex* Red Plume:** Germination even worse than #6, and appearance similar to it, except for red stems and foliage. Still not worth growing.

Table 21. Stem length, stem yield and first harvest date of four species of filler materials, grown in both field and high tunnel.

Species and Source	Stem length, cm		Stem yield, no./plant		Days to first harvest	
	Tunnel	Field	Tunnel	Field	Tunnel	Field
Bupleurum Green Gold (Johnny's)	29	35	5.4	10.0	June 27	June 25
Eucalyptus Silver Drop	59	66	15.2	9.6	Sept. 12	Sept. 7
E. Silver Dollar	65	65	12.8	8.8	Sept. 12	Sept. 19
Euphorbia Mountain Snow	39	38	8.2	13.8	June 6	June 11
Gypsophila Covent Garden (Harris)	32	30	13.4	22.4	May 28	June 1
Atriplex Green Plume (Gloeckner)	51	51	37.8	25.6	June 18	June 18
A. Red Plume	48	44	15.0	20.2	June 18	June 18

Fig. 16. *Euphorbia* Mountain Snow (left) and *Eucalyptus* Silver Drop in the high tunnel planting.

Fig. 17 (right). Eucalyptus Silver Dollar.

GLADIOLI

Many cut flower growers in upstate NY rely on gladiolus to supply them with showy and popular cut flowers most of the summer. Not having grown them on our farm, we felt it was important to learn more about the crop, and to explore if their performance would be improved by production in the high tunnel

Materials and Methods: The tall commercial mixture and the smaller-flowered border mixture were purchased from Harris Seeds and planted at intervals through late spring and summer in both tunnel and in the field on the same days. Spacing used was 6 x 6 in., with 5 rows per bed on black plastic mulch. Some plantings required support from border wires and stakes to prevent lodging of the plants, but no support netting was used.

Results and Discussion: The performance of the plantings was remarkably consistent in both tunnel and field, and also among planting dates (Table 22). In the first two plantings, plants took about 80 days to reach maturity, produced about 4 to 5 stems per ft^2, and had stem lengths slightly larger for the Commercial than the Border mix. The performance of the Border mix in the last two plantings declined, with increasing frequency of dwarf plants with bleached foliage that may have been a reaction to the alkaline soil conditions in both tunnel and the field. Nevertheless, the results indicate that gladiolus production is quite similar in both tunnel and field. The longer season in the tunnel could be of advantage for early and perhaps late plantings to extend the season.

Table 22. Stem length, yield per ft^2 and date of flowering of a series of plantings of two varieties of gladiolus (Var. 1 = Border mix; Var. 2 = Commercial mix) in both tunnel and the field. The August 13 planting only yielded a few flowers in the tunnel, none in the field.

Planting date	Stem length, cm		Stems per ft^2		Days to flower	
High tunnel	Var. 1	Var. 2	Var. 1	Var. 2	Var. 1	Var. 2
May 21	100	108	5.1	4.7	78	80
June 13	102	112	4.7	4.1	82	78
July 9	93	115	2.7	4.6	94	77
Aug. 13	110	106	0.3	0.3	91	91
Field						
May 21	91	100	4.6	4.8	78	82
June 13	100	113	4.0	4.3	81	82
July 9	79	100	1.0	3.0	80	84

POPPIES

The beautiful delicate flowers of poppy would seem to be ideal candidates for locally-produced cut flowers. Growers on the ASCFG listserve have also expressed interest in growing them, so we conducted a small introductory trial with four varieties in both high tunnel and field.

Materials and Methods: Seeds were sown directly in the high tunnel on April 3, at a 6 x 6 in. spacing with 36 hills per plot. Rep 1 was planted in a bare ground and Rep. 2 in a plastic mulch area. The field planting was sown in an area covered with black plastic mulch on May 19. To aid in emergence, the field planted seeds were covered with a thin layer of coarse vermiculite.

Results and Discussion: It was difficult to keep the tiny seed from getting dried out in the upper soil layer in the tunnel, despite frequent hand waterings, so that stand was less than 50% in most plots. In the black plastic-covered plots, soil stayed moist longer and stand was improved. Poppy was however very subject to iron deficiency in the high pH of the high tunnel, and developed yellowed foliage in spite of the use of iron chelate foliar sprays.

The postharvest life of the poppy varieties tested here is about 3 days before petals and then sepals start to abscise. This means that if harvested when the first flowers open, the flowers become messy in a short time. Pressure to use the high tunnel for other species trials cut short the harvest period in that location, and in the field, the increased temperatures also accelerated flower deterioration and shortened the harvest period. Yields shown in Table 23 thus do not reflect the true productivity of these varieties.

Table 23. Stem length, stem yield and time to flowering of four poppy varieties grown in tunnel and field.

Variety (Source)	Stem length, cm		Stems/plant		First flower date, DAP	
	Tunnel	Field	Tunnel	Field	Tunnel	Field
Papaver rhoeas Bridal Silk (Geo)	41	37	16.8	5.2	77	59
P. r. Falling in Love	46	43	11.7	3.0	76	62
P. r. Legion of Honor (Renee's Garden)	48	45	10.1	7.2	78	57
P. paeoniflorum + laciniatum Dark Grape	50	42	2.3	1.4	88	76

1. **Bridal Silk:** Thin, long stems topped by white single flowers and yellow stamens. Variety is somewhat more susceptible to iron deficiency than others tested.
2. **Falling in Love:** Stems more robust than 'Bridal Silk'; flowers vary in color from single white with pink edges, to pink blush to a red semi-double.
3. **Legion of Honor:** Plant growth similar to #2, flowers medium red, single, dark stamens and dark petal spots at flower base.
4. **Dark Grape:** a later, taller more robust plant than P. rhoeas. Flowers 4 to 5 in. diameter, maroon-purple with yellow stamens and ovary. Seed pods 1 in. wide and 2 in. long, could be used as a dried product but dry appearance is not attractive.

Fig. 18. Overview of the high tunnel poppy variety trial (left), showing 'Bridal Silk' in the foreground, 'Falling in Love' in the middle, and 'Legion of Honor' in the distance. Right: 'Dark Grape' . Note large, waxy leaves on the latter.

ORNAMENTAL CABBAGE

Materials and Methods: Seeds of the varieties were sown in mid-June in 72-cell trays in the greenhouse and transplanted to the field on July 25. In the warm summer conditions it was difficult to harden off the plants to withstand field conditions without wilting. Plants were spaced 6 x 6 in. apart and there were 25 plants per plot in 5 rows on the bed. Support netting was not sturdy enough to prevent lodging of the plants, so stems were not as erect as desirable. Plants were treated once in late September with BT to control cabbage maggot. In early October, the lowest leaves were stripped from all plants to produce a cleaner-appearing stem at harvest time.

Results and Discussion: Growth was vigorous and plants started to develop color of the young leaves and apex as temperatures cooled. This tendency varied however, as noted for the individual varieties.

1. **White with Pink Center:** Relatively large, with late color development. The pink center mentioned in the name did not appear, and 43% of the plants developed heads instead of the open, rose-like apices.
2. **Suruge na Hatsuhi:** Plants very soft and brittle at transplanting, resulting in lodging and many weak, shaded plants at harvest that contributed to low yield. Centers white with light pink leaf edges.
3. **Crane Bicolor:** Tall, sturdy plants relatively late to produce color.
4. **Lucir Rose:** Leaves lack bloom and are attractive to flea beetles. Plants smaller in stem and head size than the first 3 varieties. Earliest variety to color and be ready for harvest. Attractive and promising.
5. **Lucir White:** Bloomless leaves and smaller size, similar to 'Lucir Rose'. White color development slow, delaying harvest until late October. Twenty five percent of plants formed heads.

Table 24. Stem length and diameter, harvest date and final stand percentage of five ornamental cabbage varieties grown in the field.

Variety	Stem length, cm	Stem dia., cm	Harvest date	Stand, %
White with Pink Center (Sakata)	64	1.7	Oct. 27	98
Suruge na Hatsuhi (Geo)	54	2.0	Oct. 13	76
Crane Bicolor (Harris)	64	1.8	Oct. 27	90
Lucir Rose	49	1.6	Oct. 6	96
Lucir White	53	1.4	Oct. 27	90


LUCIR ROSE


CRANE BICOLOR


LUCIR WHITE


SURUGE NA HATSUHI