CUT FLOWER VARIETY TRIALS, ITHACA, NY, 2004

H. C. Wien, Department of Horticulture, Cornell University

INTRODUCTION: During the 2004 growing season, variety trials were conducted in Ithaca, NY on new and established varieties of cut flowers, to gain familiarity with the crops, and to determine if producing those crops in a high tunnel would improve yield and/or quality of the harvested flowers. The new varieties were part of the national cut flower variety trial coordinated by Dr. John Dole at North Carolina State University. Standard varieties were supplied through the kindness of Johnny's Selected Seeds, and the Harris Seed Company.

MATERIALS AND METHODS: The trials were conducted at the East Ithaca Gardens, on an Arkport Sandy Loam soil. The site has been in vegetable production for many years, and had muskmelons and sweet corn growing on it in 2003. Late in 2003 after those crops had been harvested, about 4 in. depth of compost was applied to the soil surface and worked in.

In November, the pipe frames of a high tunnel (Rimol Greenhouses), with dimensions of 30 x 98 ft., and 15 ft. high at the gables, were erected at the south end of the field. On April 7 the top, sides and ends were covered with a single layer of 6-mil clear polyethylene sheeting. Five beds spaced 5 ft. on center, 40 in. wide and 4-6 in. high were formed in the tunnel, with a walkway of 15 in. between beds. Two 0.015 in. black polyethylene drip irrigation lines ('T-Tape') were placed on the bed, and covered with 5 ft. wide green (IRT) polyethylene plastic mulch of 0.001 in. thickness. This material is somewhat transparent to infrared radiation, but prevents transmission of visible light and thus discourages weed growth underneath.

In the rest of the field not covered by the high tunnel, inorganic fertilizer was applied in late April at a rate of 100-21-42 (lbs/A N-P-K, using a 20-10-10 formulation). Thereafter, beds were formed with similar size, spacings and mulch coverings as in the high tunnel. Again, two trickle irrigation tubes were used per bed.

In planting of the trials, seeds were most commonly started in seedling trays in the Ken Post greenhouse, and transplanted to the tunnel/field at the appropriate time. The most typical spacing used was 4 rows of 9 x 9 in. on the bed, except where noted. The sowing and transplant dates are given in each results table. Because there were typically only 100 seeds of each variety supplied for the trial, and there were two replications for each of the trials, maximum plot sizes consisted of 24 hills.

To maintain adequate nutrient levels, $Ca(NO_3)$ at 20 lbs N per acre was applied through the trickle system twice during the season. Weekly irrigations of about 1 in. water were applied in the tunnel. Irrigation was only needed once in the outside plots, since the season was unusually rainy and cool. Air and soil temperatures were monitored in the tunnel all season, as well as air temperatures outside it, using a Hobo datalogger and

shielded probes. Probes were in shielded stands, located 15 cm above the soil surface for the air probes, and inserted 8 cm into the soil.

Stems were harvested at the recommended maturity stage for the species, and stem lengths at harvest determined. In most trials, repeated harvests were necessary, and these were continued through the summer until plant productivity declined. With the exception of the zinnia trials in both tunnel and outside, pesticide applications for disease or insect control were not necessary. For the zinnias, a mixture of Nova, Bravo and Pristine was applied to zinnias to control powdery mildew and Alternaria leafspot, beginning in early August, and repeated twice.

RESULTS AND DISCUSSION:

Temperatures in tunnel and outside: Tunnel air temperatures tended to be about 4 F higher in the tunnel than outside, with maxima rising to higher values (Table 1). These maxima were high enough to cause plant stress even in May on sunny days. Minimum temperatures were increased by smaller amounts. Soil temperatures fluctuated less than air temperatures in both maximum and minimum values, a trend visible also in the diurnal change in temperature (Fig. 1).

Table 1. Air temperatures at plant level inside and outside the tunnel, and soil temperatures in the tunnel, both under bare soil, and soil covered with green 'solar' plastic mulch. Three representative months during the 2004 growing season are shown.

Temperature	Air outside, ºF	Air in tunnel, ºF	Soil in tunnel, ºF	Soil in tunnel under plastic
May mean	63.5	68.4	67.9	74.2
May max.	78.5	89.0	74.3	81.9
May min.	50.8	54.1	61.8	67.8
June mean	66.8	69.3	70.5	76.2
June max.	81.8	87.7	77.0	83.6
June min.	54.2	55.4	64.7	70.2
Oct. mean	50.7	56.2	59.9	60.7
Oct. max.	62.3	80.4	65.3	65.8
Oct. min.	41.7	44.5	55.8	57.1

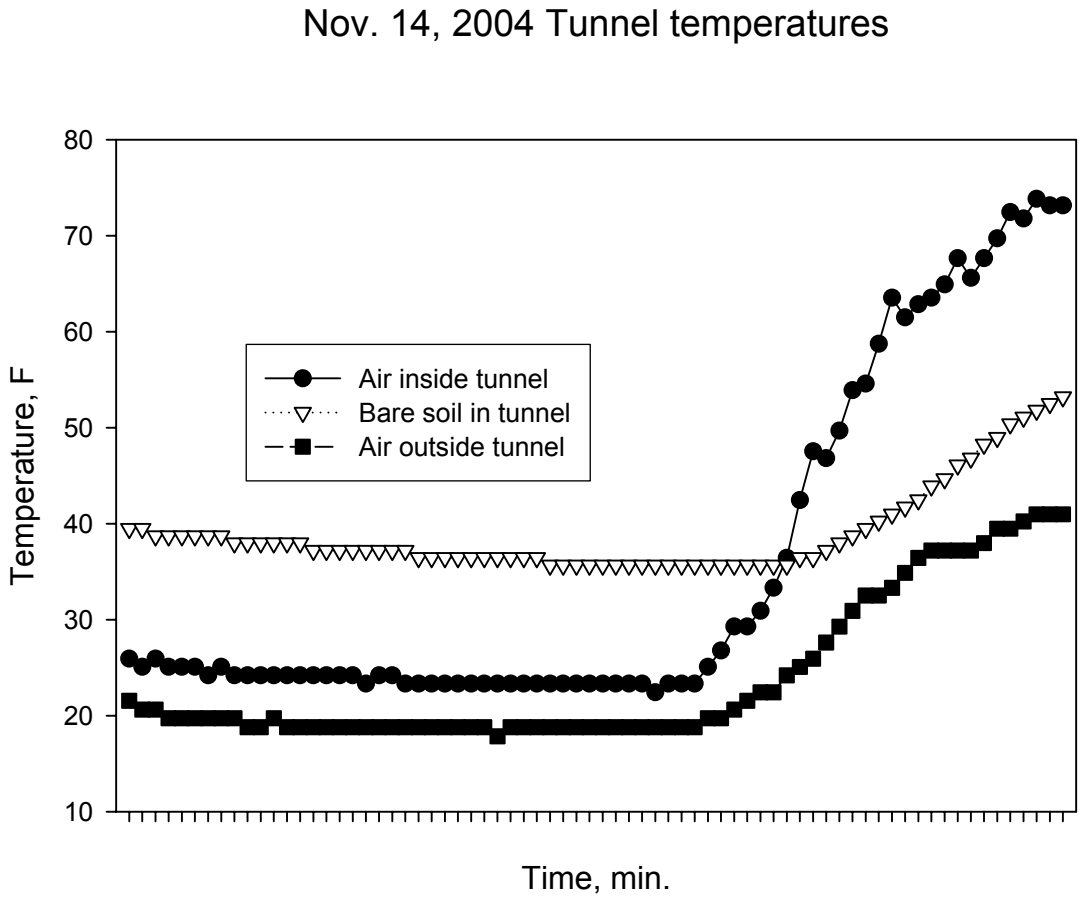

Figure 1. Temperature of air and soil inside the tunnel, and air temperature outside, on Nov. 14, 2004, from midnight to about noon.

Lisianthus: Although seedlings for both the tunnel and outside trials were sown and transplanted on the same day, the early varieties were harvested for the first time nearly 2 weeks earlier in the tunnel (Table 2). The later varieties of the Echo series did not show this advantage. In general, stem length and number of stems per plant were increased by tunnel culture. The double variety Cinderella Blue looked promising, with early production of relatively long stems. The Twinkle varieties have single blossoms and are quite productive, but showed a short vase life in water that needs to be investigated further. In limited tests, Twinkle Blue in water started wilting within 3-5 days, but showed a vase life of nearly two weeks in Aquaplus holding solution. The other varieties in this trial typically lasted at least 10 days in water.

Table 2. Stem lengths and yield per plant of 5 **lisianthus** varieties grown in a high tunnel and outside at East Ithaca, summer, 2004. Results are averages of two replications. Seeds for both trials were sown on Feb. 6, and plants were transplanted May 17 in both trials.

	Stem length, in.		Stems per plant		First harvest date	
Variety	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Cinderella blue	20.0	18.3	5.2	3.0	July 8	July 23
Twinkle Blue	18.9	16.6	5.8	3.4	July 8	July 20
Twinkle Pink	19.1	17.4	4.6	3.8	July 6	July 20
Echo Champagne	20.6	18.8	4.2	4.5	July 26	July 23
Echo Lt. blue	20.1	19.9	3.4	2.7	July 30	Aug. 8

Snapdragon: The advantages of growing cut flowers in tunnels were not evident with snapdragon (Table 3). Earliness was similar in both trials, in spite of the fact that the outside trial's plants were sown 3 weeks later than those for the tunnel. The higher yield of most varieties in the outside trial is likely due to the fact that the tunnel plants had stopped producing stems by June 30, and were removed, while harvests continued until Aug. 23 outdoors. Opus Rose, a greenhouse variety developed by Goldsmith, developed very tall stems in the tunnel, but no basal branches, whereas it branched quite liberally outside. This variety would have benefited from netting support in the outdoor trial. 'Supreme Light Lavender', a type II and III variety from Gloeckner, was early and productive in both tunnel and field. 'Rocket Mix' maintained height of the cut stems throughout the season, each plant producing about 10 useable stems in the field trial. It is still the standard variety to beat in field culture.

Table 3. Stem lengths and stems per plant of 5 **snapdragon** varieties grown in a high tunnel and outside. Results are averaged over two replications. Tunnel varieties were sown Feb. 25 and transplanted April 19; outside trial March 13 and May 15.

	Stem length, in.		Stems per plant		First harvest date	
Variety	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Supreme Light Lavender	20.7	21.2	7.0	4.3	May 28	May 30
Opus Rose	30.3	26.4	1.2	6.4	June 12	June 14
Rocket Mix	18.7	25.8	6.4	10.5	May 24	June 9
Costa Mix	20.6	21.1	5.2	7.1	May 24	May 28
Bright Butterflies	23.0	--	5.9	--	June 6	--

Zinnia: By sowing and transplanting a month earlier, harvest dates of the varieties in the tunnel were advanced by the same amount (Table 4). Nevertheless, total production of marketable stems was superior outdoors. This was largely due to the fact that production in the tunnel became unproductive by August 27, whereas the outdoor planting could be harvested until Oct. 12. Powdery mildew became a significant limiting factor in the tunnel trial, especially on 'Envy', from which the disease spread to the other varieties. In the outside trial, Alternaria was more of a limiting factor, but could be controlled with fungicide sprays.
In the cool, rainy season, less than half of the 'Benary Giant Lime' stems developed truly double flowers. In contrast, 'Oklahoma Yellow' flowers were nearly all double petaled, and of an attractive, bright color.

Table 4. Stem length and stem number per plant for five varieties of **zinnia** grown in a high tunnel and outside in summer of 2004. Data are means of two replications. Tunnel seeds were sown April 12 and transplanted as plugs on April 30; outside seeds were sown May 7 and transplanted May 25.

	Stem length, in.		Stems per plant		First harvest date	
Variety	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Benary Giant Lime	19.4	20.4	6.2	9.5	June 23	July 23
Oklahoma Yellow	17.1	17.7	10.4	17.6	June 23	July 23
Benary Giant Mix	20.4	20.8	6.7	11.2	June 23	July 23
Oklahoma Mix	17.8	18.3	9.3	16.0	June 23	July 23
Envy	20.5	--	4.2	--	June 29*	--

*"Envy" sown April 19 and transplanted May 3.

Dianthus: The traditional *Dianthus barbatus* (Sweet William) is a biennial, requiring a cold period to come to flower. The varieties under trial here are annual in their flowering habit, and make promising cut flowers. 'Amazon Neon Duo', a mixture of 'A.M.N. Cherry' and 'A.M.N. Purple' grown in this trial, was declared outstanding in the Association of Specialty Cut Flower National trials in 2003. The 'Sweet' series, also developed by PanAmerican, is about two weeks earlier than the Amazon series, and is equally productive, but somewhat shorter in stem length outdoors (Table 5). Both series started off producing long, vigorous stems, but the secondary basal branches were thinner and shorter. By late August, plants in both trials were producing only very short stems, and harvests were stopped. Although by late September new flowering stems tended to grow longer, this late flush of flowers was probably not large enough to warrant harvesting. Growing this crop in the high tunnel did not consistently increase stem length, but did result in about two weeks earlier first harvest.

Table 5. Stem length and number of stems per plant for seven varieties of **Dianthus** grown in a high tunnel, and outside in summer 2004. Data are an average of two replications. Seeds for the tunnel trial were sown March 10 and transplanted April 15; seeds for the outside trial were sown March 10 and transplanted May 14.

Variety	Stem length, in.		Stems per plant		First harvest date	
	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Sweet Purple	16.1	15.2	9.2	8.2	June 10	June 23
Sweet Red	18.0	16.5	7.2	8.5	June 13	June 23
Sweet White	16.1	15.9	6.6	8.0	June 9	June 23
Hollandia Mix	14.9	16.5	5.4	8.2	June 14	June 26
Amazon Neon Cherry	16.5	18.3	5.2	8.9	June 25	July 12
Amazon Neon Purple	20.7	20.3	7.1	9.2	June 25	July 14
Amazon Neon Rose Magic	18.0	18.5	6.6	6.9	June 28	July 7

Matricaria: This species (common name Feverfew) makes a useful filler in bouquets, and with its aromatic foliage, adds a herb-like scent that can be attractive. The new varieties Magic White and Magic Yellow (PanAmerican) were slightly later to come to flower than 'White Wonder' (Stokes), and had stiffer, more upright stems. Florets tended to be tightly clustered, making their use as a filler less appealing. As with other species, tunnel harvests could begin about two weeks earlier than outside (Table 6). The field-grown plants produced nearly twice as many stems as those in the tunnel however. Both in the tunnel and outside, the plants stopped flowering by mid-August, and only 'Magic White' resumed producing a few stems in mid-September. These were not included in the harvest totals.

Table 6. Stem length and number of stems per plant for three varieties of **Matricaria** grown in a high tunnel and outside, in summer 2004. The data are means of two replications. Seeds for the tunnel trial were sown March 3 and transplanted April 15: seeds for the outside trial were sown April 15 and transplanted May 18.

	Stem length, in.		Stems per plant		First harvest date	
Variety	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Magic White	17.1	18.0	4.7	8.4	July 2	July 23
Magic Yellow	16.7	17.5	4.5	9.4	July 6	July 23
White Wonder	20.8	19.6	4.5	8.4	June 26	July 26

Digitalis: Foxglove (*Digitalis purpurea*) is a biennial species under temperate conditions, requiring a cold period after reaching adult state to be induced to flower. In recent years, the variety Foxy was developed which flowers in the year of sowing, and may continue to grow and flower in succeeding years. The Camelot series is the newest addition to the list of first-year flowering foxgloves, and in our trial (Table 7), gave quite similar performance to 'Foxy'. All three varieties continued flowering and producing harvestable stems until frost, both in the tunnel and outside, and thus would be ideal for a

long market season. Vase life of the harvested flowers is about 7 to 9 days, especially in vase life solution. Floret drop begins at about day 5 after flower harvest, and can be counteracted by anti-ethylene treatment of the flower stems.

Table 7. Stem length and number of stems per plant for three varieties of **Digitalis** grown in a high tunnel or outside, in summer 2004. The data are means of two replications. Seeds for both trials were sown on March 10, transplanted to the tunnel on April 26, and to the field on May 11.

	Stem length, in.		Stems per plant		First harvest date	
Variety	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Camelot Cream	19.4	18.5	20.4	20.8	July 5	July 20
Camelot White	20.8	21.6	14.8	11.7	July 5	July 20
Foxy	20.5	19.6	13.0	26.3	July 11	July 20

Celosia: Cockscomb celosia is a rapidly-growing heat-loving plant that did well under tunnel conditions (Table 8). The new variety being tested, Bombay Fiora, stood out in earliness, being ready for harvest a month before the other varieties in the trial. It was unusual in its lack of branches, both in the tunnel and outside. Topping this variety at about node 6 before onset of flowering did not result in branch production; the plants developed thick stems and leaves, but branching was still inhibited. The other varieties had few branches in the tunnel, but produced many basal branches of medium length in the outdoor trial, with small combs that would be useful in bouquets. Stem length was considerably greater in the tunnel than outside, especially for 'Bombay Fiora'. The outdoor trial was much later in flowering than the tunnel experiment, but that was due largely to its delayed transplant date, and the deliberate decision to delay harvesting until the central comb had reached large size. Vase life in water for these varieties appeared to be at least one week.

Table 8. Stem length, number of stems per plant and dates of first harvest for five **cockscomb celosia** varieties grown in a high tunnel and outdoors. Data are a mean of two replications in each location. Seeds for the tunnel trial were sown March 17 and transplanted April 30; sowing date for the outdoor trial was April 15, and transplant date May 29.

	Stem length, in.		Stems per plant		First harvest date	
Variety	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Bombay Fiora	22.8	18.7	1.0	1.0	May 28	July 14
Cramer's Lemon Lime	24.2	19.8	3.3	8.4	June 24	Aug. 8
Kurume Corona	24.8	22.1	7.0	7.8	June 24	Aug. 8
Cramer's Rose	24.8	20.9	1.4	6.9	June 24	Aug. 8
Cramer's Burgundy	27.2	19.4	1.9	9.0	June 23	Aug. 8

Sunflower: Only 100 seeds of each of the new varieties being tested were supplied for this trial. This restricted the ability to adequately evaluate variety performance, especially since we decided to have two replications in both tunnel and outdoor locations.

This meant that individual plots consisted at best of 24 plants. Given the tremendous range in mature plant height of the different varieties in this trial, the potential for considerable interference from one plot to the neighboring one was great. In the tunnel trial, we direct-seeded into a bed of relatively low N status, and the resulting growth of some varieties was not satisfactory (Table 9). Growth in the field trial was under more normal fertility conditions, and was more representative of normal growth. Comparing the first harvest date of the two trials, this was the only species that flowered at the same time in the tunnel and outdoors, or even earlier outdoors. Of the varieties tested, the Procut lines showed promise with strong single stems and pollen-less flowers of attractive appearance. 'Starburst Lemon Aura' produced more branches, even at the close spacing used (4 x 6 in.), but these were too short to be useful except in small bouquets. For more realistic evaluations of these and other varieties, please refer to the trial results from the Harris trial, conducted outdoors next to this one at about the same time.

Table 9. Stem length, flower disk diameter and first harvest date for 8 **sunflower** varieties grown in a high tunnel and outdoors. Data are a mean of two replications in each location. Seeds for the tunnel experiment were direct-seeded on April 23; seeds for the outdoor trial were sown in plug trays May 5, and transplanted on May 17.

Variety	Stem length, in.		Flower disk dia., in.		First harvest date	
	Tunnel	Outside	Tunnel	Outside	Tunnel	Outside
Procut Lemon	34.2	35.4	2.5	3.0	July 5	July 10
Procut Bicolor	23.0	40.8	1.7	3.8	July 5	July 6
Procut Orange	14.7	39.8	1.2	3.6	July 5	July 6
Sunrich Gold	60.8	59.2	2.8	3.5	Aug. 8	July 17
Sunbright Supreme	60.8	61.2	2.8	3.3	July 30	July 22
Starburst Lemon Aura	30.0	38.6	1.4	2.0	Aug. 3	July 30
Moulin Rouge	68.6	62.4	2.7	3.6	July 10	July 13
Zebulon	22.8	34.8	1.6	2.2	July 30	July 20

Ornamental Kale: The trials were timed to be harvested in the cool fall weather, to stimulate optimum color development of the apical leaves. Assuming that tunnel conditions would allow plants to grow later into the fall, the sowing date of the outside trial was more than 2 weeks earlier than the tunnel trial. In the mild fall weather of 2004, the plants outside grew vigorously, and developed longer stems, than those in the tunnel. The latter may have suffered from low soil N levels. Color development was more pronounced for the trial growing outside, and the apex was more compact, with less stem elongation and more attractive grouping of apex leaves than in the tunnel. Cabbage butterfly larvae were more prevalent in the tunnel than outside, and aphid pressure occurred to a greater extent in the tunnel as well. Among the varieties tested, Sunrise tended to be more damaged by cabbage worms than the other varieties. 'Rose Crane' and 'Red Crane' were more uniform in their appearance than 'Sunrise' and 'Sunset', but all

four were acceptable. Harvested stems had a vase life of more than two weeks, but apex color tended to change from white to green in 'Sunrise', while stem elongation at the apex reduced attractiveness of all varieties after a week in the vase.

Table 10. Plant height at final harvest (Oct. 28) for four **ornamental kale** varieties grown in a high tunnel and outdoors. Data are for two replications in each location. Seeds for the tunnel experiment were sown on July 16, for outside planting on June 29, in plug trays. Transplant dates were August 10 and Aug. 2, respectively.

	Plant height, in.	
Variety	In tunnel	Outside
Rose Crane	12.9	16.1
Red Crane	13.9	17.2
Sunrise	14.9	17.0
Sunset	16.0	16.4

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