Productivity and Profitability of Some Field-grown Specialty Cut Flowers

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Abstract. The productivity and profitability of annual and perennial field-grown specialty cut-flower species were evaluated for the southeastern United States. Data were collected on 20 annuals and 20 perennials in 1992 and on 19 annuals and 19 perennials (10 in their second year of production) in 1993. Productivity and profitability were based on yield and stem length measurements. Yield was expressed as total number of stems harvested. Income per 30-cm center was predicted from the number of stems ≥ 41 cm long that were harvested. Some species had high yields but stem lengths were too short for most market outlets. Among those species that combined high yield with long stems and resulted in high profitability without major pest or postharvest problems were the perennials *Achillea filipendulina* Lam., *Echinacea purpurea* (L.) Moench, *Liatris spicata* (L.) Willd., and *Platycodon grandiflorus* Jacq. A. DC. and the annuals *Antirrhinum majus* L., *Cosmos bipinnatus* Cav., *Scabiosa atropurpurea* L., and *Zinnia elegans* Jacq. Low overhead of field production coupled with productive species could prove to be profitable.

The demand for cut flowers in the United States continues to increase, and the outlook for growing cut flowers in the 1990s is positive. There is a developing market for cut annuals and perennials (specialty crops) that are grown in the field. A wide range of climatic conditions are required for growth of these specialty cut-flower species. This need provides growers in all regions with an opportunity to secure the market for crops well-adapted to their environmental conditions.

The market size and profit potential have led numerous entrepreneurs to attempt to find a profitable cut-flower production and marketing system (Kelly, 1991). In addition, many farmers are seeking ways to diversify their operations and improve profit margins (Kelly, 1991). Research with various production techniques affecting yield and stem length has been conducted on a limited number of field-grown cut-flower species. Such production techniques have included spacing (Armitage, 1987), successive planting dates (Armitage and Laushman, 1990a, 1990b), shading (Armitage, 1991), types of herbicide (Gilreath, 1985), and fertilizer application rate (Paparozzi and Hatterman, 1988). Yield potential and flowering habit of numerous *Limonium*

sinuatum L. cultivars were determined (Whipker and Hammer, 1994), and postharvest handling methods for field-grown *Physostegia purpurea* Blake have been studied (Kelly and Starman, 1990). Our objective was to determine the yield and stem lengths of a wide range of specialty annual and perennial cut-flower species, to examine their adaptability to growing in the field in the southeastern United States, and to predict profitability from this information.

Materials and Methods

Field studies were conducted in 1992 and 1993. In 1992, 20 annual and 20 perennial species were started from seed in early spring. Seeds were sown in germination trays containing commercial soilless medium (Jiffy Mix; Jiffy Products of America, West Chicago, Ill.) and placed under intermittent mist until emergence. When plants had developed first true leaves, they were transplanted into cell packs containing a commercial soilless medium (Pro-Mix BX; Premier Brands, New Rochelle, N.Y.). Seedlings were grown in a glasshouse with 24C day/18C night set points until they were transplanted to the field. Fertilization with each irrigation using 20N–4.4P–16.6K with N at 100 mg·liter⁻¹ was increased to 200 mg N/liter after 2 weeks. The plants were transplanted from the cell packs to the field at the Knoxville Agriculture Expt. Station on 5 May 1992. Plants were supported as needed with bamboo stakes and layers of string mesh vertically spaced 25 cm apart.

The field soil was plowed and disked before planting. A granular 11N–4.7P–9.1K fertilizer was scattered over the surface of the soil and incorporated at 0.16 kg·m⁻². Plants were placed on 30-cm centers and watered in. After planting, a preemergent herbicide (Treflan, Dow, Indianapolis) was applied at 0.05 kg·m⁻² followed by a 5- to 10-cm layer of pine-straw

mulch for weed control. An herbicide (Poast; BASF-Wyandotte, Parsippany, N.J.) was applied to control grasses along the edges of the beds. Additional weed control throughout the experiment was hand-cultivation. A drip irrigation system was used to supplement rainfall as needed.

Four 1.8 × 30-m raised beds were used for the experiment. Two beds were planted with 20 annual cut-flower species and two beds with 20 perennial cut-flower species. The species chosen for the experiment were among those listed in seed catalogs as suitable for cutting. The experiment was a randomized complete-block design with 16 plants per species in each bed (total plants per species = 32). The 16 plants within a block were planted together in a four × four square. The position of the species within the bed was randomly assigned. The treatment arrangement was a split plot with species and location in the statistical model. Location was defined as the placement of the individual plants in the square, either border or interior. The general linear model (SAS Institute, Cary, N.C.) was used as the analysis of variance procedure, and means were separated by Duncan's multiple range test.

Harvesting of individual species was conducted weekly beginning in June and continued until 1 Sept. 1992. Data collected included first harvest date, total number of harvested stems, and stem length. Total number of harvested flowers was the number of flowers harvested weekly from all plants of that species. Flowers were cut as single stems or sprays depending on the flowering habit of the species. At each harvest, stems were cut to the same node for each species.

In 1993, 19 species and/or cultivars of annuals and nine perennials were planted in the field in addition to 10 perennials that remained in the field from the previous year. We used the same cultural practices as described for the study performed in 1992; the seedlings were transplanted to the field 5 May. Seed of *Helianthus annuus* L. cultivars was sown directly in the field. Harvesting started in June and ended on 1 Sept.

Profitability was predicted using data from the 1993 trials for the 10 perennials in second-year production and 10 top-performing annuals (i.e., lacking major insect and disease problems and having postharvest longevity). Data for annuals and perennials were analyzed separately. Predicted income per 30-cm center was the product of the percentage of harvested bunches per 30-cm center that had stem lengths ≥ 41 cm multiplied by total bunches per 30-cm center. This figure was then multiplied by \$3.00 per bunch, an estimate based on an average sale price per bunch (Marguiles, 1991). From this figure, an average production cost of \$0.98 (total variable costs + fixed costs) per 30-cm center and labor costs were subtracted (Brumfield, 1992). Labor costs ranged from \$0.06 per 30-cm center for species harvested twice to \$0.15 per 30-cm center for species harvested 12 times. We chose 41 cm as the minimum stem length acceptable for marketability (Barr, 1992). Bunches per 30-cm cen-

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ter were calculated by dividing total number of flowers harvested per 30-cm center by 10, based on the industry's standard of 10 stems per bunch.

Results

The analysis showed no statistical differences due to location of individual plants, so it will not be considered further. There was no difference between replications for any of the measured variables. Differences due to species were significant ($P \leq 0.01$) for all variables.

Annual species (1992). Total number of stems harvested in a replication varied due to species (Table 1). *Ageratum houstonianum* Mill. 'Blue Horizon', *Salvia farinacea* Benth. 'Victoria', *Scabiosa atropurpurea* 'Olympia Hybriden', *Verbena bonariensis* L., and *Zinnia elegans* 'Pink Ruffles' each produced >1400 stems per replication and were not statistically different from each other. All other species produced <500 flowers and were similar in this respect.

Consolida regalis S.F. Gray 'Bluebell' and *Psylliostachys suworowii* (Regel) Roshk. produced few stems because all plants died by the end of the experiment. The few stems harvested from *Craspedia globosa* Benth. and *Helichrysum bracteatum* (Venten.) Andr. 'King Silvery Rose' were partially due to delayed production (Table 1); also, several healthy plants of these species failed to bloom. For all other species, all of the plants produced flowers.

The two annual species with the longest stems were *C. globosa* and *V. bonariensis*, each averaging ≈ 50 cm. *Antirrhinum majus* 'Axiom Yellow', *Celosia spicata* (Thouars.) K. Spreng. 'Flamingo Feather', and *H. bracteatum* 'King Silvery Rose' had average stem lengths >41 cm. In retrospect, *A. houstonianum* 'Blue Horizon' and *Z. elegans* 'Pink Ruffles' could have been cut with longer stems, but potential flowers would have been removed in the process, reducing total yield.

Six of the 20 species of annual cut flowers were not included in Table 1 because of differences in harvest method. These species included three everlastings (*Nigella damascena* L. 'Miss Jekyll', *Scabiosa stellata* L. 'Ping Pong', and *Xeranthemum annuum* L. 'Mischung') and three fresh flowers [*Aster novi-belgii* L. 'Benary's Composition', *Bupleurum griffithii* L., and *Caryopteris incana* (Thunb.) Miq.]. With the exception of *B. griffithii*, these species produced many short-stemmed flowers that were too numerous to cut as single stems. Growers would need to harvest the entire crop of flowers from these species at one time. *Bupleurum griffithii* differed from the other species because each plant produced one stem of flowers and then died after harvest. Growers should schedule multiple plantings of this species to maximize yield over the entire growing season.

Annual species (1993). Harvesting began in June 1993, with the exception of *H. annuus* cultivars and *Trachymene coerulea* R.C. Grah 'Himmelblau', which were not harvested until

July or thereafter (Table 2). Total number of stems harvested in a replication varied due to species. The largest total number of flowers harvested per replication was produced by *Centaurea cyanus* L. 'Polka Dot Mix', three cultivars of *Cosmos bipinnatus*, and *S. atropurpurea* 'Imperial Mix'. All other species yielded >200 flowers, except *Cotula turbinata* L., *Eustoma grandiflorum* (Raf.) Shinn. 'Yodel Blue', and *H. annuus* cultivars. Two species that failed to produce marketable flowers in our trials were *Carthamus tinctorius* L. and *Vaccaria pyramidalata* Medic.

The annual species with the longest stems were *H. annuus* cultivars. Most species had stem lengths of ≥ 41 cm. Only *Callistephus chinensis* L. Nees 'Miss Mexico' and *C. cyanus* 'Polka Dot Mix' had stem lengths significantly <41 cm.

Perennial species (1992). The few flower stems produced the first year by some of the perennial species were partly due to delayed production, which did not begin until mid-July or August (Table 3). Seven species of perenni-

als either did not bloom or produced only one or two flower stems throughout the growing season. Two cultivars of *Chrysanthemum parthenium* (L.) Bernh. ('Schneeball' and 'White Pompon') produced many short-stemmed flowers that were too numerous to cut as single stems and, therefore, were not included in Table 3. Growers would need to harvest these flowers in bunches. The two most productive species (*Dianthus barbatus* L. 'Pride of Park Ave.' and *Platycodon grandiflorus* 'Fugi Blue') began blooming early and bloomed continuously throughout the growing season. They also had the shortest stems, along with *Echinacea angustifolia* DC. *Liatris spicata* 'Floristan Violet' had the longest stems (Table 3). Two species that had stem lengths ≥ 41 cm were *Achillea filipendulina* 'Cloth of Gold' and *Goniolimon tataricum* (L.) Boiss. All other perennials had stems <41 cm the first year of production.

Perennial species (1993). Total number of stems produced in a replication varied with species (Table 4). Species in their second year

Table 1. Average number of field-grown, specialty, annual, cut-flower stems harvested and average stem length, 1992 season.

Species	Cultivar	Seed source ^z	First harvest date	No. stems/replication ^y	Stem length (cm)
<i>Ageratum houstonianum</i>	Blue Horizon	BA	18 June	1803 a	27 d
<i>Antirrhinum majus</i>	Axiom Yellow	BE	25 June	286 b	43 b
	Rocket Pink	BA	11 June	478 b	36 c
<i>Celosia spicata</i>	Flamingo Feather	VA	31 July	427 b	44 b
<i>Consolida regalis</i>	Bluebell	PA	11 June	108 b	22 d-f
<i>Craspedia globosa</i>		BE	16 July	35 b	52 a
<i>Helichrysum bracteatum</i>	King Silvery Rose	BA	14 Aug	174 b	43 b
<i>Limonium sinuatum</i>	Pastel Shades	BA	18 June	265 b	37 c
<i>Matthiola incana</i>	Apple Blossom	TM	11 June	233 b	11 g
<i>Psylliostachys suworowii</i>		BA	11 June	158 b	17 fg
<i>Salvia farinacea</i>	Victoria	PA	12 June	1588 a	18 ef
<i>Scabiosa atropurpurea</i>	Olympia Hybriden	BE	22 July	1946 a	24 de
<i>Verbena bonariensis</i>		BA	18 June	1450 a	49 ab
<i>Zinnia elegans</i>	Pink Ruffles	BA	11 June	1675 a	27 d

^zBA = Ball Seed Co., West Chicago, Ill.; BE = Benary, Hunden, Germany; PA = Park Seed Co., Greenwood, S.C.; TM = Thomson-Morgan Seed Co., Jackson, N.J.; VA = Vaughan's Seed Co., Downer's Grove, Ill.

^yMean separation by Duncan's multiple range test at $P \leq 0.05$.

Table 2. Average number of field-grown, specialty, annual, cut-flower stems harvested and average stem length, 1993 season.

Species	Cultivar	Seed source ^z	First harvest date	No. stems/replication ^y	Stem length (cm)
<i>Antirrhinum majus</i>	Rocket Bronze	VA	6 June	327 cd	45 c-e
	Rocket White	VA	6 June	260 c-f	45 c-e
<i>Callistephus chinensis</i>	Miss Mexico	BE	29 June	277 c-f	32 gh
<i>Carthamus tinctorius</i>	Lasting Yellow	SK	---x	0	---
<i>Centaurea cyanus</i>	Polka Dot Mix	PA	15 June	588 ab	32 gh
<i>Cirsium japonicum</i>	Rose Beauty	SK	22 June	212 c-f	51 bc
<i>Cosmos bipinnatus</i>	Early Wonder	PA	6 June	695 a	55 b
	Versailles Carmine	SK	6 June	664 a	49 b-d
	Versailles Red	PA	6 June	822 a	49 b-d
<i>Cotula turbinata</i>		PA	15 June	190 c-f	38 e-g
<i>Dianthus barbatus</i>	Red Empress	SK	22 June	296 c-e	27 h
<i>Eustoma grandiflorum</i>	Yodel Blue	VA	29 June	85 d-f	41 d-f
<i>Helianthus annuus</i>	Full Sun	BA	20 July	18 f	70 a
	Sunbright	BA	23 Aug.	13 f	70 a
	Sunrich Lemon	BA	20 July	16 f	70 a
<i>Scabiosa atropurpurea</i>	Imperial Mix	BA	15 June	821 a	38 e-g
<i>Trachymene coerulea</i>	Himmelblau	BE	6 July	333 cd	46 c-e
<i>Vaccaria pyramidalata</i>	Pink Beauty	BA	---x	0	---
<i>Zinnia elegans</i>	Scarlet Splendor	VA	6 June	360 bc	47 b-e

^zBA = Ball Seed Co., West Chicago, Ill.; BE = Benary, Hunden, Germany; PA = Park Seed Co., Greenwood, S.C.; SK = Sakata Seed Co., Salinas Calif.; VA = Vaughan's Seed Co., Downer's Grove, Ill.

^yMean separation by Duncan's multiple range test at $P \leq 0.05$.

^xFlowers were not harvested.

began producing ≈ 4 to 12 weeks earlier in 1993 than in 1992 (Tables 3 and 4). *Veronica spicata* L. 'Rosa Zwerg' produced the most stems. *Dianthus plumarius* L. 'Spring Beauty Mix', *Echinacea purpurea* 'Magnus', and *Geum quellyon* Sweet 'Mrs. Bradshaw Imp.' were equally productive. The most productive species were in their second year of production. An exception was *Coreopsis lanceolata* L. 'Early Sunrise', which yielded >500 stems its first year in production but averaged only 21 cm in stem length. There were no differences in total number of stems harvested among the other species, indicating some species are equally productive during the first year of production as others are during the second year.

Nine of 10 perennial species produced more stems per replication in the second year of

production than in the first year; the exception was *P. grandiflorus* 'Fuji Blue' (Tables 3 and 4). The first year it had a spreading growth habit and produced numerous short-stemmed flowers that were cut individually. The second year plants grew upright and flower stems were cut as sprays. Seven species in the second year of production had stem lengths ≥ 41 cm; *Centranthus ruber* (L.) DC. 'Roseus', *D. plumarius* 'Spring Beauty Mix', and *Veronica spicata* L. 'Rose Zwerg' did not.

Predicted profitability. Some species of perennials were harvested throughout the growing season (nine to 12 times); others flowered only for a short time (Table 5). Most annual species were harvested throughout the entire growing season. *Helianthus annuus* 'Sunrich Lemon' and *T. coerulea*

'Himmelblau' were harvested only three or four times. Number of bunches per 30-cm center with ≥ 41 -cm stem length ranged from 0.22 to 3.16 for the perennials and 0.10 to 4.92 for the annuals.

Of the second-year perennials, only *C. ruber* 'Roseus' and *D. plumarius* 'Spring Beauty Mix' had negative predicted income, but this result was not statistically different from *A. incarnata*, *E. planum*, or *V. spicata* 'Rosa Zwerg'. For some, the negative predicted income was due to inadequate stem lengths rather than number of harvests. Among the annuals, only *H. annuus* 'Sunrich Lemon' had a negative predicted income per 30-cm center, although several other species did not differ from it statistically.

Sensitivity of income to a change in price. Figure 1 shows the impact on income of a change in price per bunch using the production costs chosen for this study. A high-yielding species like *Achillea filipendulina* 'Cloth of Gold' that was predicted to be highly profitable when sold at \$3.00 per bunch could be sold for <\$1.00, if necessary, before the grower would incur a loss (income < 0). Growers would break even (income = 0) growing *Liatris spicata* 'Floristan Violet' if market price decreased 60%, from \$3.00 to \$1.20 per bunch. Producers would need to charge at least \$2.17 per bunch to recover their cost of growing *Veronica spicata* 'Rosa Zwerg', unless costs were reduced or yields with adequate stem length increased. *Centranthus ruber* 'Roseus' yielded the fewest bunches per 30-cm center (0.22) and would be profitable only if the market price were >\$5.00 per bunch. Thus, a grower may elect not to incur the cost of growing this species if the price were below this level.

Discussion

The species that began producing shortly after field planting and continued to produce many flowering stems per plant throughout the growing season resulted in a large total for harvested stems and the greatest profit potential. Overall, the annual species were more productive than the first-year perennial species. These results were expected because perennials usually do not reach their reproductive potential until the second growing season. Production of perennial species as field-grown cut flowers became more profitable the second year.

Stem length of flowers would be a consideration of marketability. Most florists prefer longer stem lengths than are required for mass market outlets. When a cut-flower stem's length is <41 cm, it has to be outstanding in some other characteristic to justify its production (Barr, 1992). Species should be selected that have adequate stem length to satisfy the potential market. However, published stem length information is not always available or may be inaccurate, and stem length can vary with cultural practices or environmental conditions. Stem length of field-grown cut flowers has been increased by shading plants with 55% shade cloth, but yield was reduced (Armitage,

Table 3. Average number of field-grown, specialty, perennial, cut-flower stems harvested and average stem length, 1992 season.

Species	Cultivar	Seed source ^z	First harvest date	No. stems/replication ^y	Stem length (cm)
<i>Achillea filipendulina</i>	Cloth of Gold	BA	20 Aug.	12 d	52 b
<i>Asclepias curassavica</i>		BA	2 July	265 c	36 c
<i>Asclepias incarnata</i>		BA	---	---	---
<i>Centranthus ruber</i>	Roseus	BA	14 Aug.	35 d	34 cd
<i>Dianthus barbatus</i>	Pride of Park Ave.	BA	12 June	710 b	21 f
<i>Dianthus plumarius</i>	Spring Beauty Mix	BA	14 Aug.	120 cd	33 cd
<i>Echinacea angustifolia</i>		NI	14 Aug.	16 d	24 ef
<i>Echinacea purpurea</i>	Magnus	BA	20 Aug.	131 cd	31 d
<i>Echinops ritro</i>	Royal Globe	BA	---	---	---
<i>Eryngium planum</i>		BE	---	---	---
<i>Goniolimon tataricum</i>		BA	7 Aug.	43 d	49 b
<i>Geum quellyon</i>	Lady Stratheden	BA	---	---	---
	Mrs. Bradshaw Imp.	BA	---	---	---
<i>Liatris spicata</i>	Floristan Violet	BA	28 Aug.	8 d	67 a
<i>Limonium latifolium</i>		BA	---	---	---
<i>Limonium perezii</i>		BA	---	---	---
<i>Platycodon grandiflorus</i>	Fuji Blue	BA	17 July	1501 a	10 g
<i>Veronica spicata</i>	Rosa Zwerg	BE	17 July	45 d	34 cd

^zBA = Ball Seed Co., West Chicago, Ill.; BE = Benary, Hunden, Germany; NI = Nicholl's Gardens, Albany, Ore.

^yMean separation by Duncan's multiple range test at $P \leq 0.05$.

^zFlowers were not harvested.

Table 4. Average number of field-grown, specialty, perennial, cut-flower stems harvested and average stem length, 1993 season.

Species	Cultivar	Seed source ^z	First harvest date	No. stems/replication ^y	Stem length (cm)
<i>Achillea filipendulina</i>	Cloth of Gold	(92) ^x	1 June	262 cd	60 cd
<i>Asclepias incarnata</i>		(92)	6 June	61 d	51 de
<i>Catananche coerulea</i>		VA	---	---	---
<i>Centranthus ruber</i>	Roseus	(92)	12 May	219 d	35 f-h
<i>Chrysanthemum coccineum</i>	Robinson's Mix	PA	---	---	---
<i>Coreopsis lanceolata</i>	Early Sunrise	PA	15 June	522 bc	21 i
<i>Dianthus barbatus</i>	Tall Early Kurokawa	SK	29 June	23 d	23 hi
<i>Dianthus caryophyllus</i>	Chabaud Giant	PA	15 June	72 d	45 e-g
<i>Dianthus hybrid</i>	Miss Biwako	BA	29 June	66 d	41 e-g
<i>Dianthus japonica</i>	Ginza Red	SK	---	---	---
<i>Dianthus plumarius</i>	Spring Beauty Mix	(92)	20 May	672 b	33 f-i
<i>Echinacea purpurea</i>	Magnus	(92)	6 June	569 b	47 d-f
<i>Eryngium planum</i>		(92)	29 June	110 d	114 a
<i>Geum quellyon</i>	Mrs. Bradshaw Imp.	(92)	12 May	526 bc	52 de
<i>Liatris spicata</i>	Floristan Violet	(92)	22 June	143 d	91 b
<i>Physostegia virginiana</i>	Schneckrone	BE	10 Aug.	101 d	52 de
<i>Platycodon grandiflorus</i>	Fuji Blue	(92)	15 June	165 d	70 c
<i>Veronica spicata</i>	Rosa Zwerg	(92)	20 May	1017 a	32 g-i
	Sightseeing	PA	14 July	180 d	41 e-g

^zBA = Ball Seed Co., West Chicago, Ill.; BE = Benary, Hunden, Germany; PA = Park Seed Co., Greenwood, S.C.; SK = Sakata Seed Co., Salinas, Calif.; VA = Vaughan's Seed Co., Downer's Grove, Ill.

^yMean separation by Duncan's multiple range test at $P \leq 0.05$.

^xIndicates field planting in 1992.

^zFlowers were not harvested.

1991). Cutting stems at a lower node during one harvest may decrease flower production at subsequent harvests because flower buds are

removed. Some of our most productive species had stem lengths that were too short for many market outlets.

Table 5. Total number of harvests, number of bunches per 30-cm center (≥ 41 -cm stem length), and predicted income per 30-cm center for perennial and annual, field-grown, specialty, cut flowers, 1993.

Species	Cultivar	Total no. harvests	No. bunches/30-cm center (≥ 41 -cm stem length) ²	Predicted income/30-cm center (\$)
<i>Perennial species</i>				
<i>Achillea filipendulina</i>	Cloth of Gold	5	1.54 b	3.56 b
<i>Asclepias incarnata</i>		4	0.38 cd	0.08 c-e
<i>Centranthus ruber</i>	Roseus	9	0.22 d	-0.45 e
<i>Dianthus plumarius</i>	Spring Beauty Mix	9	0.32 cd	-0.15 de
<i>Echinacea purpurea</i>	Magnus	12	2.60 a	6.68 a
<i>Eryngium planum</i>		2	0.69 cd	1.02 c-e
<i>Geum quellyon</i>	Mrs. Bradshaw Imp.	9	3.16 a	8.38 a
<i>Liatris spicata</i>	Floristan Violet	6	0.89 bc	1.60 b-d
<i>Platycodon grandiflorus</i>	Fugi Blue	6	0.99 bc	1.90 bc
<i>Veronica spicata</i>	Rosa Zwerg	12	0.52 cd	0.44 c-e
<i>Annual species</i>				
<i>Antirrhinum majus</i>	Rocket Bronze	12	1.50 bc	3.36 bc
	Rocket White	12	0.99 b-d	1.85 b-d
<i>Cirsium japonicum</i>	Rose Beauty	10	1.17 b-d	2.41 b-d
<i>Cosmos bipinnatus</i>	Early Wonder	12	4.02 a	10.92 a
	Versailles Carmine	12	3.92 a	10.63 a
	Versailles Red	12	4.92 a	13.62 a
<i>Cotula turpinata</i>		10	0.53 cd	0.48 cd
<i>Eustoma grandiflorum</i>	Yodel Blue	9	0.40 cd	0.11 cd
<i>Helianthus annuus</i>	Sunrich Lemon	3	0.10 d	-0.76 d
<i>Scabiosa atropurpurea</i>	Imperial Mix	10	1.89 b	4.55 b
<i>Trachymene coerulea</i>	Himmelblau	4	1.59 bc	3.71 bc
<i>Zinnia elegans</i>	Scarlet Splendor	12	1.68 bc	3.91 bc

²Mean separation in columns within type of species by Duncan's multiple range test at $P \leq 0.05$.

Fig. 1. Sensitivity of income to a change in price for four perennial, field-grown, specialty cut flowers: (◇) *Achillea filipendulina* 'Cloth of Gold', (■) *Liatris spicata* 'Floristan Violet', (*) *Veronica spicata* 'Rosa Zwerg', (◇) *Centranthus ruber* 'Roseus'.

Spacing would also have an effect on productivity and, thus, profit. Two annual species (*H. annuus* and *E. grandiflorum*) yielded few flowers per plant but had more upright growth habits, allowing closer spacing than the 30 cm we used. Armitage (1987) found that field-grown cut flowers responded to spacing treatments by producing fewer flowering stems per plant with closer spacing; however, production per unit area increased as spacing decreased for all species.

The predicted profitability figures are estimates, and growers need to determine their own costs of production. Markets dictate sale price per bunch. Prices for cut flowers vary considerably during the year and generally peak around major holidays (Kelly, 1991). Some species appeared to be extremely profitable due to the high total number of flower stems harvested, adequate stem lengths, and relatively low cost of field production. However, a grower must establish a market that can absorb the supply of flowers produced.

Although the most productive species were the most profitable, growing only one or two species may not be feasible. When choosing the best, overall, field-grown, specialty cut flowers, susceptibility to pest problems, ease of postharvest handling (petal-shattering, milky sap, thorns, etc.), and postproduction longevity should be considered. Lower overhead in field compared to greenhouse production, coupled with productive species, could prove profitable, provided a market is established.

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