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Evaluation of zinnia cultivars for field grown cut flower production

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Abstract

The objective of the study was to evaluate the effects of cultivar and planting date on zinnia (*Zinnia elegans*) cut flower production. Parameters evaluated were the number of days to harvest, duration of harvest period for each planting date, number of stems per plant, stem length and diameter. Plants from the May planting date produced stems over a longer period of time compared to plants from the June and July plantings with the exception of 'Scarlet Splendor' from the July planting. Within each of the three planting dates, there were no statistically significant differences in the number of stems produced per plant due to the cultivar effect for 10 of the 13 cultivars evaluated. A trend of increasing stem and bloom size from the May planting date to the July planting was observed. The median number of stems produced by the zinnia cultivars in this study from the May, June, and July planting dates were respectively 21.6, 10.8 and 14.5 stems per plant for plants spaced one foot apart in the row. The potential stem yield for a single 100 ft row of the zinnia cultivars included in this trial was 2160, 1080 and 1450 stems for the production life of May, June, and July plantings, or 4690 stems for the three plantings combined. The cut flower zinnias evaluated in this study were very productive during the summer growing season.

Key words: *Zinnia elegans*, zinnia, cut flower, field production

Introduction

Floriculture and ornamental crop production has grown to be one of the largest segments of U.S. agriculture, and in 2003 with a farm value of $14.4 billion, trailed only corn and vegetables in value among crops (Jerardo, 2004). Cut flower production, a segment of the floriculture industry, in the U.S. in 2006 had an estimated value of $385 million. This was about half the value of imported cut flowers in 2006, $750 million (Jerardo, 2006). These production figures are for 'mainstream' florist flowers that are produced in ideal microclimates around the world and then transported to distant markets.

In US, there is growing interest in producing specialty cut flowers that are not considered 'traditional' cut flowers but are still in demand by florists, designers, and consumers (Armitage, 1993). Research efforts have identified floral crops that can be produced in Mississippi that meet the quality criteria of local florists who have indicated a willingness to purchase these crops if supply and quality were available (Sloan and Harkness, 2002; Sloan *et al.*, 2003). Other studies indicated that zinnia has excellent field production potential (Starman *et al.*, 1995). The Association of Specialty Cut Flower Growers conducted on-farm trials to identify superior cut flower cultivars, including zinnia, for field production (Dole, 2005). The 'Benary's Giant' series of zinnia was awarded the Association of Specialty Cut Flower Growers Cut Flower of the Year in 1999 (ASCFG, 1999). The 'Benary's Giant' series has been an industry standard for cut flower zinnia since then. An inclination by consumers to purchase locally produced flowers has been identified. Hudson and Griffin (2004) reported that consumers responding to survey indicated a willingness to pay a premium price for flowers grown in Mississippi compared to those flowers grown outside of Mississippi. The objective of this study was to evaluate the effects of cultivar and planting date on zinnia cut flower production.

Materials and methods

Thirteen zinnia cultivars were seeded into 1204 cells containing Metro Mix 366 media on three dates: April 25, May 27, and June 30, 2003. The seedlings were fertilized with 100 ppm (mg L^{-1}) N using Peter's Peat Lite Special 20-10-20 water soluble fertilizer (20N-4.3P-16.7K; The Scotts Company, Marysville, OH) until the first leaf emerged after which they were fertilized with 250 ppm (mg L^{-1}) N from Peter's 20-10-20. The seedlings were drenched with Banrot (etridiazole + thiophanate methyl) at a rate of 59.15 mL / 3.78 L prior to transplanting to the plant beds. The seedlings were transplanted to raised field beds on a Savannah sandy clay loam soil at the North Mississippi Research & Extension Center in Verona, Miss. (lat. 34.2° N, long. 88.8° W) on three dates; May 19, June 20, and July 27, 2003. Raised beds were formed with a three-point hitch bed shaper. The beds were 0.76 m across the top and were spaced 1.52 m center to center. A single drip tape was placed in the center of the bed and buried 2.54 cm below the bed surface. The beds were fertilized before planting with 8-8-8 (8N-3.5P-6.6K IMC Rainbow Agribusiness, Florence, AL) at a rate of 0.45 kg 9.29 m^{-2} of bed. Beds were fertigated weekly at the rate of 0.25 kg of Peter's 20-20-20 (20N-8.8P-16.5K) per 92.90 m^2 during the growing season. Irrigation was supplied as needed through the drip tape to provide 1892.70 L/92.90 m^2 of row per irrigation. The experimental design was a split plot with the planting date being the whole plot factor, and the cultivar being the sub-plot factor with four replications. The experimental unit consisted of two plants of each cultivar that were planted in

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pairs, one plant on each of two parallel rows that were spaced 30.5 cm apart; the plants within each row were spaced 30.5 cm apart. Zinnia stems were harvested as soon as the blooms were completely opened. Stems were not harvested unless they were at least 45.7 cm long. The data collected during the trial were analyzed by SAS PROC MIXED (SAS Institute Inc, Cary, NC). Means separation were conducted with Fisher's Protected LSD at P=0.05. The data recorded in this experiment were date of harvest, stem length, stem diameter, bloom diameter, and number of stems per plant.

Results and discussion

There was an interaction between planting date and cultivar in the analysis of days to first harvest. Within the May planting date, 'Envy', 'Sun Red', 'Benary's Giant Crimson', 'Benary's Giant Carmine Rose', 'Yoga', and 'Cactus Jewels Mix' needed more time to produce the first mature stems, 44.7–42.2 days, compared to 'Benary's Giant Scarlet', 'Scarlet Splendor', and 'State Fair Mix', 38.0 days (Table 1). 'Scarlet Splendor' took longer to grow to maturity, 45.1 days, than the other cultivars in the June planting except 'Envy' and 'Benary's Giant White'. 'Benary's Giant Carmine Rose' required longer, 51.0 days, than the other cultivars in the July planting to grow to maturity while 'Scarlet Splendor' and 'Sun Red' required the least amount of time, 27.0 days. There were no statistical differences between the May and July planting dates in the time required to produce mature stems for 'Benary's Giant Crimson', 'Benary's Giant Deep Red', 'Benary's Giant Mix', 'Benary's Giant White', 'Cactus Jewels Mix', 'Envy', 'Ruffles Scarlet', 'State Fair Mix', and 'Yoga'. These findings disagree with those of Young *et al.* (2003) where zinnias planted in June took longer to grow to harvest compared to those planted in May. Within the 'Benary's Giant' series, there were biologically inconsequential, but statistically significant, differences in the time required to grow to maturity due to planting date for 5 of the 6 cultivars, but 'Benary's Giant Carmine Rose' was the notable exception.

Multiple stems are generally harvested from zinnia plants over a period of time. Cultivars that keep producing stems over long periods would be desirable for cut flower growers. There was an interaction between planting date and cultivar for the duration of the harvest period. 'Benary's Giant Deep Red' produced stems over a longer period of time than the other cultivars in this trial for plants from the May and June plantings, 85.0 and 55.0 days, respectively (Table 2). The June planting date of 'State Fair Mix' had a shorter harvest period, 41.7 days, than 'Benary's Giant Deep Red', but longer than the other cultivars. 'Scarlet Splendor' and 'Sun Red' produced stems over a longer period, 56.0 and 52.0 days, compared to the other cultivars in the July planting. The duration of harvest period was shorter for plants from the June and July plantings compared to the May planting for all cultivars except 'Scarlet Splendor' in July. This suggests that the plants from the May planting were stronger compared to those from the other planting dates.

Plants of 'Benary's Giant Deep Red' from the May planting date produced more stems per plant (34.6) during the life of the plant than the other cultivars in the May planting. 'Benary's Giant Deep Red' followed only 'Sun Red' in production in the June planting, and was in the top statistical grouping for cultivars in the July planting for number of stems per plant (Table 3). Comparisons within each cultivar across planting dates showed that plants from the May planting produced more stems for 10 of the 13 cultivars compared to the June planting. However, comparisons between the May and July planting dates with regard to the number of stems produced per plant show that 9 of the 13 cultivars showed no significant difference due to planting date. Within each of the

Table 1. Effects of cultivar and planting date on the number of days required to grow stems to first harvest maturity for zinnia cultivars[z]

Cultivar	Days required to first harvest		
	Planting date		
	May 19	June 20	July 27
Benary's Giant Carmine Rose	43.7 b A[x]	39.0 c B	51.0 a A
Benary's Giant Crimson	44.0 a A	38.5 b B	44.0 a B
Benary's Giant Deep Red	41.0 ab AB	39.0 b B	44.0 a B
Benary's Giant Mix	41.0 a AB	39.0 a B	40.0 a B
Benary's Giant Scarlet	38.0 b B	39.0 b B	43.9 a B
Benary's Giant White	40.7 a AB	41.2 a AB	40.0 a B
Cactus Jewels Mix	42.2 ab AB	39.0 b B	44.0 a B
Envy	44.7 a A	42.7 a AB	44.0 a B
Ruffles Scarlet	40.7 ab AB	39.0 b B	44.0 a B
Scarlet Splendor	38.0 b B	45.1 a A	27.0 c C
State Fair Mix	38.0 b B	39.7 ab B	43.0 a B
Sun Red	44.7 a A	40.0 a B	27.0 c C
Yoga	42.5 a A	39.7 a B	40.5 a B

LSD (cultivar) = 4.4299[w], LSD (date) = 4.7578[y]

[z]There was an interaction between cultivar x planting date (P<0.0001) in the analysis of the number of days required to first harvest of cultivars. Two comparisons; one within the cultivar and across planting dates, and the other within planting date and across cultivars; were needed for the analysis.

[y]LSD within cultivar and across planting dates

[x]Means compared by Fisher's Protected LSD at P=0.05. Means with the same-upper case letter in a column do not differ at the 5% significance level. Means with the same lower-case letter in a row do not differ at the 5% significance level.

[w]LSD within planting date and across cultivars

Table 2. Effects of cultivar and planting date on the duration of the harvest period of zinnia cultivars[z]

Cultivar	Duration of harvest period		
	Planting date		
	May 19	June 20	July 27
Benary's Giant Carmine Rose	54.2 a C[x]	25.2 b C	32.0 b CD
Benary's Giant Crimson	54.0 a C	23.5 c CD	39.0 b BC
Benary's Giant Deep Red	85.0 a A	55.0 b A	28.0 c D
Benary's Giant Mix	57.0 a BC	15.2 c DE	43.0 b B
Benary's Giant Scarlet	63.0 a B	25.2 c C	38.9 b BC
Benary's Giant White	55.5 a BC	19.0 c CD	41.2 b B
Cactus Jewels Mix	55.7 a BC	21.9 c CD	39.0 b BC
Envy	53.2 a C	17.5 c C-E	38.5 b BC
Ruffles Scarlet	57.2 a BC	21.9 c CD	35.5 b B-D
Scarlet Splendor	54.7 a BC	9.2 b E	56.0 a A
State Fair Mix	63.0 a B	41.7 b B	40.0 b BC
Sun Red	56.2 a BC	24.2 b C	52.0 a A
Yoga	57.7 a BC	22.5 c CD	42.5 b B

LSD (cultivar) = 8.5975[w], LSD (date) = 9.2875[y]

[z]There was an interaction between cultivar x planting date (P<0.0001) in the analysis of the number of days required to first harvest of cultivars. Two comparisons; one within the cultivar and across planting dates, and the other within planting date and across cultivars; were needed for the analysis.

[y]LSD within cultivar and across planting dates

[x]Means compared by Fisher's Protected LSD at P=0.05. Means with the same-upper case letter in a column do not differ at the 5% significance level. Means with the same lower-case letter in a row do not differ at the 5% significance level.

[w]LSD within planting date and across cultivars

Table 3. Effects of cultivar and planting date on the number of stems produced per plant by zinnia cultivars[z]

Cultivar	Stems produced per plant		
	Planting date		
	May 19	June 20	July 27
Benary's Giant Carmine Rose	20.1 a B-E[x]	8.7 b C	13.4 ab C-E
Benary's Giant Crimson	21.7 a B-D	11.9 b C	21.5 a AB
Benary's Giant Deep Red	34.6 a A	22.2 b B	25.7 b A
Benary's Giant Mix	17.0 a C-E	8.7 b C	14.1 a C-E
Benary's Giant Scarlet	21.6 a B-E	13.6 b C	15.3 ab B-E
Benary's Giant White	16.2 a DE	9.9 a C	10.8 a E
Cactus Jewels Mix	26.1 a B	8.8 b C	14.0 b C-E
Envy	18.4 a C-E	9.1 b C	14.5 ab B-E
Sun Red	22.4 b B-D	29.7 a A	26.0 ab A
Ruffles Scarlet	21.9 a B-D	10.8 b C	11.9 b DE
Scarlet Splendor	14.6 a E	15.5 a BC	20.1 a A-C
State Fair Mix	19.4 a B-E	8.9 b C	12.0 b DE
Yoga	23.2 a BC	12.1 b C	17.9 ab B-D
LSD (cultivar) = 7.0753[w] , LSD (date) = 7.300[y]			

[z]There was an interaction between cultivar x planting date (P=0.05) in the analysis of the number of days required to first harvest of cultivars. Two comparisons; one within the cultivar and across planting dates, and the other within planting date and across cultivars; were needed for the analysis.

[x]LSD within cultivar and across planting dates

[y]Means compared by Fisher's Protected LSD at P=0.05. Means with the same-upper case letter in a column did not differ at the 5% significance level. Means with the same lower-case letter in a row did not differ at the 5% significance level.

[w]LSD within planting date and across cultivars

Table 4. Effects of cultivar and planting date on zinnia stem length

Cultivar	Stem length (cm)
Benary's Giant Carmine Rose	49.05 ab[y]
Benary's Giant Crimson	48.68 abcd
Benary's Giant Deep Red	48.18 d
Benary's Giant Mix	48.89 abc
Benary's Giant Scarlet	48.39 cd
Benary's Giant White	49.16 ab
Cactus Jewels Mix	49.05 abc
Envy	48.5 bcd
Sun Red	48.96 abc
Ruffles Scarlet	47.56 e
Scarlet Splendor	48.51 bcd
State Fair Mix	49.23 a
Yoga	49.12 ab
LSD	0.7025
Planting Date	**Stem length (cm)**
May 19	48.95 a
June 20	48.97 a
July 27	48.22 b
LSD	0.4313

[y]Means compared by Fisher's Protected LSD at P = 0.05. Means within a column with the same letter did not differ at the 5% significance level.

three planting dates, there were no statistical differences in the number of stems produced per plant for 10 of the 13 cultivars.

For stem length there was no planting date x cultivar interaction (Table 4). The stem length ranged from 49.2-47.6 cm. 'Ruffles Scarlet' produced the shortest stem 47.6 cm. The decision of not to harvest and record stems that were less than 45.7 cm in length reduced the possibility for differences to be observed in stem length. Differences in productivity were reflected in the number of stems harvested per plant. The May and June planting dates produced statistically longer stems compared to the July planting date.

Table 5. Effects of cultivar and planting date on zinnia stem diameter

Cultivar	Stem diameter (cm)
Benary's Giant Carmine Rose	0.83 cd[y]
Benary's Giant Crimson	0.82 de
Benary's Giant Deep Red	0.93 ab
Benary's Giant Mix	0.81 de
Benary's Giant Scarlet	0.88 bcd
Benary's Giant White	0.79 e
Cactus Jewels Mix	0.81 e
Envy	0.67 f
Sun Red	0.79 e
Ruffles Scarlet	0.67 f
Scarlet Splendor	0.90 bc
State Fair Mix	0.99 a
Yoga	0.83 de
LSD	0.0719
Planting Date	**Stem diameter (cm)**
May 19	0.79 b
June 20	0.85 a
July 27	0.83 a
LSD	0.0497

[y]Means compared by Fisher's Protected LSD at P = 0.05. Means within a column with the same lower-case letter do not differ at the 5% significance level.

Table 6. Effect of cultivar and planting date on bloom diameter of zinnia cultivars[z]

Cultivar	Bloom diameter (cm)[y]		
	Plant date		
	May 19	June 20	July 27
Benary's Giant Carmine Rose	8.01 ab BC[w]	7.79 b C-E	8.50 a C-E
Benary's Giant Crimson	7.77 b B-D	8.15 ab A-C	8.64 a C-E
Benary's Giant Deep Red	7.27 b D	7.28 b EF	8.12 a E
Benary's Giant Mix	7.55 b CD	7.71 b C-E	8.94 a CD
Benary's Giant Scarlet	7.83 a B-D	7.10 b FG	8.40 a DE
Benary's Giant White	7.52 b CD	7.24 b EF	8.32 a E
Cactus Jewels Mix	8.07 b BC	8.49 b AB	9.59 a B
Envy	6.74 a E	6.56 a G	6.68 a F
Sun Red	7.27 b DE	7.48 b D-F	8.30 a E
Ruffles Scarlet	5.54 b E	5.56 b H	6.34 a F
Scarlet Splendor	8.22 b B	8.00 b B-D	9.02 a BC
State Fair Mix	9.01 b A	8.66 b A	10.09 a A
Yoga	7.51 b CD	6.91 c FG	8.32 a E
LSD (cultivar) = 0.5837[v], LSD (date) = 0.5915[x]			

[w]There was an interaction between cultivar x planting date (P=0.0297) in the analysis of bloom diameter. Two comparisons; one within cultivar across planting dates and the other within planting date across cultivars; were needed for the analysis.

[v]LSD within cultivar and across planting dates

[w]Means compared by Fisher's Protected LSD at P=0.05. Means with the same upper-case letter in a column do not differ at the 5% significance level. Means with the same lower-case letter in a row do not differ at the 5% significance level.

[x]LSD within planting date across cultivars

'State Fair Mix' produced larger diameter stems (0.99 cm) than the other cultivars in this trial except 'Benary's Giant Deep Red' while 'Envy' and 'Ruffles Scarlet' produced the smallest diameter stems (0.67 cm) (Table 5). The June and July planting dates produced larger diameter zinnia stems on an average than the May planting date.

The bloom diameter of 'State Fair Mix' was larger within each of the three planting dates compared to the other cultivars except for 'Cactus Jewels Mix' and 'Benary's Giant Crimson' from the June planting date (Table 6). 'Envy' and 'Ruffles Scarlet' produced smaller blooms than the other cultivars except 'Sun Red' in May. The trend in bloom diameter across planting dates

was the same for stem diameter. Nine of the 13 cultivars produced larger diameter blooms in the June and July plantings compared to the May planting.

The May planting of zinnia cultivars in this trial produced plants that yielded stems for a longer period of time. Many of the zinnia cultivars within the June planting date had a shorter harvest period, probably due to stressful, hot weather conditions at transplanting. While, 'Benary's Giant Deep Red' produced flower stems over the longest period of time in the May and June plantings, it was at the bottom of the list for duration of stem production for the July planting. Within each planting date, there were no statistical differences in harvest duration for 8 of the 13 cultivars, which could indicate that there was little difference between the cultivars for this response. While there was little difference in stem length due to planting date or cultivar, there was a trend for increased stem and bloom diameter from May to the July planting date. 'Benary's Giant Deep Red' and 'Sun Red' were consistently the top producers of flower stems across the 3 planting dates. For each planting date, there was relatively little difference between the other cultivars regarding the number of stems produced per plant. However, the median number of stems produced by all cultivars from the May, June, and July planting dates were respectively 21.6, 10.8, and 14.5 stems per plant that were planted 30.5 cm apart in the row. This would result in a potential stem yield for a single 30.4m row of zinnia cultivars included in this trial of 2160, 1080 and 1450 stems for the production life of May, June, and July plantings, or 4690 stems for the three plantings combined.

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