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Establishment Success and Relative Costs of Four Annual Species for Roadside Planting

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ADDITIONAL INDEX WORDS. wildflowers, *Celosia argentea* 'Pampas Plumes', *Cosmos sulphureus*, *Helianthus annuus* '7111', *Zinnia elegans* 'Gold Medal Mixture'

SUMMARY. Seeds of *Celosia argentea* L. 'Pampas Plumes', *Cosmos sulphureus* Cav., *Helianthus annuus* L. '7111', and *Zinnia elegans* Jacq. 'Gold Medal Mixture' were mixed with clean sand and hand-broadcasted over 60-ft² (6.7-m²) plots at rates of 4 or 8 oz./1000 ft² (122 or 244 g/100 m²). Each plot was either left undisturbed after sowing or the seed was raked into the soil surface. Estimated costs were calculated using the approximate number of seeds planted per plot and the cost per seed versus the number of plants reaching anthesis. *Celosia* and *Zinnia* bloomed for 42 days, *Cosmos sulphureus* for 28 days, and *Helianthus* for 12 days. Seeding rate had little effect on the number of plants maturing to flower in all species except *Cosmos*. There were no significant differences in number of weeds between treatments for any of the species. Raking the seed into the soil significantly improved germination at 2.5 and 5 weeks for *Celosia*, *Cosmos*, and *Helianthus*, but not for *Zinnia*. In *Celosia*, raking the seed into the soil more than doubled the number of

plants maturing to flower, while in *Cosmos* the number reaching anthesis was not significantly altered by raking. The lowest costs per flowering plant occurred when the seed was raked into the soil for *Celosia*, *Helianthus*, and *Zinnia*.

Flowers have been popularized as an alternative to turf for roadside planting. Their use has increased since the 1960s and early 1970s when they were heavily promoted by Lady Bird Johnson in the beautify America movement (Johnson and Lees, 1988). Early promotion of wildflowers led to the development of a national roadside beautification program in 1973 by the Federal Highway Administration. In Texas, North Carolina, Virginia, Vermont, and other states, extensive floral plantings have increased the visibility and public awareness of this program. Of all the highway programs, the roadside beautification program receives the most accolades and support from the public, whereas safety and utility programs are often taken for granted (Baker and Barrett, 1990; Johnson and Lees, 1988). Wildflowers break up the monotony of roadside vegetation and can provide a calming effect on motorists in areas of heavy traffic (Billings, 1990). They have also been cited as a way to reduce maintenance costs while providing aesthetic variety to the roadside. While wildflowers are not maintenance free, their maintenance costs have been reported to be less than those for turf (Billings, 1990), but this may not be consistent for all states (Bartels, 1992).

Good seed to soil contact and ample moisture are required for successful wildflower seed germination (Dusablon, 1988; Martin, 1986), with some relief from overcrowding by invasive weeds also required. The primary objective when planting is to get as many desirable plants established with as few weeds as possible, including grasses, to produce the maximum visual impact (Dusablon, 1988). For roadsides, however, elimination of all weeds is rarely possible and often unnecessary. A few weeds may become "invisible" to the motorist traveling at normal highway speeds.

Two considerations arise when examining suitable species for roadside planting: prospective species or-

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Table 1. Blooming dates and length of bloom period for 4 annual species. All seed was planted 3 June 1994 and the experiment was terminated on 1 Sept. 1994.

Species	Bloom (1994)		Days (no.)
	Begin	End	
<i>Celosia argentea</i> 'Pampas Plumes'	20 July	1 Sept. ^z	42
<i>Cosmos sulphureus</i>	25 July	25 Aug.	28
<i>Helianthus annuus</i> '7111'	31 July	12 Aug.	12
<i>Zinnia elegans</i> 'Gold Medal Mixture'	20 July	1 Sept. ^z	42

^zStill in flower at this date.

Table 2. Seed cost (\$) and number of seeds per ounce for each species used in this experiment.

Species	Seeds/oz	Cost (\$)/oz	Cost (\$)/seed
<i>Celosia argentea</i> 'Pampas Plumes'	36848	68.60	0.00186
<i>Cosmos sulphureus</i>	4060	1.18	0.00029
<i>Helianthus annuus</i> '7111'	448	0.56	0.00126
<i>Zinnia elegans</i> 'Gold Medal Mixture'	3276	8.54	0.00261

namental potential and innate potential for stand establishment (Dusablon, 1988; Rose-Fricker, 1991). Establishment of wildflower seed varies greatly depending on environment (Dusablon, 1988). Annuals are often recommended over perennials for their superior floriferousness, length of bloom, and their flexibility to change planting sites from year to year (Stroud, 1989). Many perennials establish well the first year but fail to survive additional years and annuals may vary greatly in reseeding ability (Rose-Fricker, 1991).

The objective of this research was to determine if flow success rates resulting from broadcast seeding could be improved by increasing the seed quantity sown and insuring good seed-soil contact. The establishment, display potential, and costs were examined in four annual species.

Materials and Methods

Four species of annuals, selected for their ability to grow and flower rapidly from seed and their ornamental display potential, were sown at rates of 4 or 8 oz/1000 ft² (122 or 244 g/100 m²). The species used were *Celosia argentea* 'Pampas Plumes' (Germania Seed Co., Chicago, Ill.), *Cosmos sulphureus* (Applewood Seed Colo., Arvada, Col.), *Helianthus annuus* '7111' (Agway Inc., Elizabethtown, Pa.), and *Zinnia elegans* 'Gold Medal Mixture' (Germania Seed Co.). The seed was mixed with clean sand and hand-broadcasted over each plot on 3

June 1994. Each plot was either left undisturbed after sowing or the seed was manually raked into the soil surface. Each plot in this 2 × 2 × 4 factorial (seed rate × soil raking × species) measured 60 ft² (6.7 m²) and was replicated three times in a completely randomized design.

The number of seeds germinated was counted in three random 1-ft² (900-cm²) transects at 2.5 and 5 weeks after seeding. At bloom, existing weeds and flowering plants from sown seeds were counted in three random 1-ft² transects. Dates of flowering were also recorded for each species until the experiment was terminated on 1 Sept. 1994 (Table 1).

The number of seeds per ounce was counted and the cost per seed calculated (Table 2). The approximate number of seeds planted per plot and the cost per seed versus the number of plants reaching anthesis was used to calculate the cost per plant, an estimate of cost efficiency. The following formula was developed to calculate the cost per plant: $E = (C \cdot S) / N$, where E = cost per plant, C = seed cost, S = number of seeds planted, and N = number of plants flowering.

Results

Celosia and *Zinnia* bloomed from the end of July to the end of the experiment in early September (Table 1). *Cosmos sulphureus* remained in flower for 4 weeks, from late July to late August. *Helianthus* had the short-

est bloom time, only 12 d.

While *Celosia* was the most expensive seed on a per weight basis, *Zinnia* was more expensive on a per seed basis (Table 2). *Cosmos* was the least expensive on a per seed basis and *Helianthus* seeds were the heaviest with only 0.60 seeds/oz. (16 seeds/g).

There was no interaction between seed rate and the use of site raking, so the main effects of each were examined. Doubling the amount of seed sown significantly increased the observed germination after 2.5 weeks for all species except *Helianthus* (Table 3). After 5 weeks, only germination in *Cosmos* and *Zinnia* remained significantly different at the two seeding rates. Seeding rate had little effect on the number of plants maturing to flower; only *Cosmos* responded significantly, showing an approximate 50% improvement by doubling the sowing rate. The cost per plant for *Cosmos* and *Zinnia* was not significantly different between seeding rates but was significantly different for *Celosia* and *Helianthus*. At flowering, the number of weeds in all the plots was the same, regardless of seed rate, and also numbered fewer than those species planted, except for *Helianthus*. Poor germination was recorded for all treatments using *Helianthus*.

Raking the seed into the soil significantly improved observed germination at 2.5 and 5 weeks for *Celosia*, *Cosmos*, and *Helianthus*. The number of seedlings reaching flowering was significantly higher when the seeds were raked into the soil for *Celosia*, *Helianthus*, and *Zinnia*, more than doubling this response for *Celosia* and *Helianthus*. The initial, improved germination of *Cosmos* due to raking did not result in a significant impact on flowering. In *Celosia* and *Helianthus*, raking the seed into the soil resulted in significantly lower costs per plant at flowering. Raking had no significant effect on weed numbers at the time of flowering.

Discussion

Initial seed cost may be misleading and some potential species for roadside use may be overlooked because they appear too expensive. *Celosia* is one of those species. While the cost per gram appears prohibitively expensive, the per seed cost is actually lower than *Zinnia*. The combination of raking in

Table 3. Performance comparison of four annual species based on seed rate and planting method. Cost per plant is in U.S. dollars.

Treatment	Germination (no.) ^z		Flowering plants (no.) ^z	Cost (\$)/plant ^y	Weeds (no.) ^z
	2.5 weeks	5 weeks			
<i>Celosia argentea</i> 'Pampas Plumes'					
Seed rate					
8 oz/1000ft ²	67 a ^x	62 a	27 a	2.03 a	6 a
4 oz/1000ft ²	39 b	42 a	19 a	1.26 b	7 a
Planting					
Raked	75 a	74 a	32 a	1.01 a	5 a
Not raked	31 b	31 b	14 b	2.28 b	8 a
<i>Cosmos sulphureus</i>					
Seed rate					
8 oz/1000 ft ²	14 a	18 a	11 a	0.07 a	3 a
4 oz/1000 ft ²	9 b	9 b	7 b	0.05 a	6 a
Planting					
Raked	14 a	16 a	11 a	0.05 a	4 a
Not raked	9 b	11 b	8 a	0.07 a	5 a
<i>Helianthus annuus</i> '7111'					
Seed rate					
8 oz/1000 ft ²	0.3 a	0.6 a	0.9 a	0.54 a	13 a
4 oz/1000 ft ²	0.3 a	0.4 a	0.4 a	0.17 b	17 a
Planting					
Raked	0.7 a	0.8 a	1.2 a	0.21 a	15 a
Not raked	0.0 b	0.1 b	0.1 b	0.99 b	11 a
<i>Zinnia elegans</i> 'Gold Medal Mixture'					
Seed rate					
8 oz/1000 ft ²	15 a	16 a	11 a	0.52 a	9 a
4 oz/1000 ft ²	9 b	9 b	8 a	0.52 a	6 a
Planting					
Raked	12 a	14 a	12 a	0.34 a	6 a
Not raked	12 a	11 a	7 b	0.71 a	9 a

²Number of seeds germinated, plants flowering, or weeds per 1-ft² transect.

³Cost per plant: $E = (C \cdot S) / N$, where E = cost per plant, C = seed cost, S = number of seeds planted, and N = number of plants flowering.

^xMean separation for each species within columns by seed rate or planting using Student-Newman-Keuls test, $P = 0.05$.

the seed and using a lower seed rate can lower the actual cost to acceptable levels. Seed rates cannot be arbitrarily reduced for all species as a means of reducing costs. *Cosmos* is one species that demonstrated a reduced floral display with reduced seed quantity. An increase in seed quantity for this species did not significantly increase the cost per flowering plant. For three of the four species tested, raking the seed into the soil to provide good seed to soil contact increased the number of seeds germinating. This early establishment was also evident in greater numbers of plants flowering and resulted in a suitable floral display for

roadside planting. In most species tested, simply doubling the amount of seed planted did not compensate for good seed to soil contact in plant establishment. Except for *Helianthus*, all species tested provided good floral display with a minimum of 28 d in bloom.

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