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Effects of Seed Priming on Plug Production of *Coreopsis lanceolata* and *Echinacea purpurea*[1]

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Abstract

Seeds of *Coreopsis lanceolata* (coreopsis) and *Echinacea purpurea* (purple coneflower) were primed to determine whether improved plug production of these herbaceous perennials would result. Experiments were conducted at two locations: Texas A&M University (TAMU), College Station, Texas; and Buell's Inc., Cibolo, Texas. Location had a significant effect on emergence, with both species having greater emergence percentages at Buell's Inc. than at TAMU. This effect is attributed mainly to watering systems and plug aeration. Priming significantly increased emergence of only *E. purpurea* grown at TAMU. Seedlings from seeds primed in 50 mM potassium salts for nine days at 15°C (59°F) had more than twice the emergence percentage (47%) of seedlings from nonprimed seeds (21%). Priming did have a significant effect on the root development of both species. *Echinacea purpurea* seedlings from primed seeds had a 44 to 51% increase in total root area compared to nonprimed seeds. *Coreopsis lanceolata* seedlings from primed seeds had up to an 85% increase in root area compared to seedlings from nonprimed seeds. In plug systems, relatively developed root systems may result in positive growth response after transplanting.

Index words: perennials, coreopsis, purple coneflower

Significance to the Industry

The same factors enhancing the usefulness of plugs in nursery production, i.e. small, compartmentalized cells reducing competition between plants and making transplanting easier, also intensify problems such as saturated soils and poor soil aeration not associated with standard production procedures (2, 11). Seed priming has demonstrated an ability to improve germination and emergence of seeds under stress conditions such as extreme temperature and excessive moisture (4, 8, 15, 16). In this study, when plugs were grown under less than ideal conditions, primed seeds of *E. purpurea* performed better than did nonprimed seeds even though germination was greatly reduced. When greenhouse conditions were ideal, the benefits of priming were not as obvious because the germination of all treatments improved. Priming did result in greater root development for both species, which may be significant in terms of improved transplanting and response to transplanting.

[1]Received for publication November 26, 1991; in revised form April 1, 1992. Texas Agricultural Experiment Station Journal Article. no. 30471.

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Introduction

One of the greatest opportunities for economic success in the nursery industry in recent years has been the production and sale of potted perennials (13, 14, 17). The use of plug production systems can enable growers to take advantage of this opportunity by producing great quantities of perennials economically and efficiently (2, 7, 11).

One of the keys to successful plug production is vigorous, uniform seedlings produced from quality seed germinating rapidly and uniformly (2, 7, 11). Unfortunately, many herbaceous perennials have complex dormancy systems creating problems for commercial producers (12). Seed priming is a pregerminative treatment used to improve germination performance of two perennial species, *C. lanceolata* (coreopsis) and *E. purpurea* (purple coneflower) (15, 16). Yet, no research has been done to evaluate the benefits of priming perennial seed for use with plug production systems.

The purpose of this study was to determine whether priming improves emergence and growth during perennial plug production under normal greenhouse conditions.

Materials and Methods

Greenhouse experiments were conducted at Texas A&M University (TAMU) in College Station, Texas and at Buell's

Inc., a commercial greenhouse operation in Cibolo, Texas. Priming treatments were modifications of the most successful treatments used by Samfield et al. (15, 16) on the species used in the present study.

In August 1989, seeds of *C. lanceolata* and *E. purpurea* were placed in paper mesh bags and suspended in plastic three-liter bottles containing aerated solutions of either double-distilled water (ddH_20) or 50 mM potassium phosphate buffer (KH_2PO_4 + K_2HPO_4, pH 7.0). *Coreopsis lanceolata* was primed for 6 days at 15°C (59°F) or for 3 days at 26°C (79°F). *Echinacea purpurea* was primed for nine days at 15°C (59°F) or for one day at 26°C (79°F). Each solution was aerated using plastic tubing connected to two 115V PennPlax (PennPlax Plastic, Inc., Garden City, NY) aquarium pumps. After priming, seeds were removed, rinsed thoroughly in ddH_20 for 60 s, and air dried at room temperature (26 ± 1°C, 79 ± 1°F) for 24 hours. Controls were the untreated dry seed of each species.

After seeds were air dried, 10 replications of 40 seeds each were planted, one seed per cell, in #200 plug trays (A.H. Hummert's, St. Louis, MO) containing a soilless medium (Redi-Earth Mix, Cambridge, MA). Seeds were planted at a depth of approximately 1 cm (0.4 in). Five replications of each species were tested at both locations. For 28 days, plug trays were germinated under mist at 28 ml (0.84 oz) H_2O per emitter over 6 s every 6 min at TAMU and at 187 ml (5.61 oz) H_20 over 4 s every 32 min at Buell's Inc. Ambient temperatures in the TAMU greenhouse averaged 28°C (82°F) day/18°C (64°F) night. Ambient greenhouse temperatures at Buell's Inc. averaged 32°C (90°F) day/21°C (70°F) night. Seedlings were fertilized weekly with 200 ppm N ($20N-10K_20-20P_20_5$).

Daily emergence counts of the number of seedlings having two cotyledons appearing above the soil surface were taken on the first day following planting through day 28 at TAMU and day 31 at Buell's. .The experiment was conducted as a 2 × 2 factorial with a separate control in a completely randomized design. An analysis of variance was conducted, and mean separations were determined by Student-Newman-Keuls' (SNK) Test (18).

A second experiment was initiated in November 1989 at TAMU to examine the effects of priming on specific growth parameters of seedling plugs of *C. lanceolata* and *E. purpurea*. Seeds of both species were primed and planted according to the methods described previously. Four replications of 30 samples each were seeded for each species. Seeds were germinated under mist with 187 ml (5.61 oz) H_20 emitted per emitter for 4 s every 32 min. Bottom heat was set at 22°C (72°F). Trays were drenched with Banrot® fungicide (14 mg a.i./1 H_20) on day 3 and fertilized once at 200 ppm N ($20N-10K_20-20P_20_5$) on day 25. Ambient greenhouse temperatures averaged 23°C (73°F) day/17°C (63°F) night, and the soil temperature averaged 22 ± 1°C (72 ± 1°F). An additional 16 replications of each treatment, 30 samples per replication, were grown for destructive sampling.

At the 3 to 4 leaf stage an electronic "Digimatic" caliper (Mirutoyo Corp., Tokyo, Japan) was used to take growth measurements on five representative seedlings of each treatment. The distance between the tips of the first true leaves was measured for *C. lanceolata*, and the length of the leaf blade of the first true leaf was measured for *E. purpurea*.

Five representative seedlings were selected from the additional replications for destructive sampling every three days until the end of the experiment. Data that was collected included leaf spread or blade length, shoot and root lengths, shoot and root areas by means of a Li-Cor Portable area meter (Model LI-3000), and root and shoot dry weights.

Results and Discussion

Location did have a significant effect on the emergence of both species, with a greater total percentage emergence for both species occurring at Buell's Inc. than at TAMU (Tables 1 and 2). At Buells, seeds of *C. lanceolata* had a mean final emergence of 51% for all treatments combined, compared with one of 40% for identical treatments at TAMU. Mean final emergence for all treatments of *E. purpurea* seeds was 86% at Buell's and 33% at TAMU.

Priming significantly increased seedling emergence of only one of the species at one location when data were analyzed on a weekly basis. Priming in 50mM potassium salts for nine days at 15°C (59°F) significantly increased seedling emergence of *E. purpurea* at TAMU throughout the study (Table 1). By termination, more than twice as many seedlings (47%) had emerged from primed seeds than from nonprimed seeds (21%).

Table 1. Effects of priming on seed emergence of *Echinacea purpurea* and *Coreopsis lanceolata* at Texas A&M Horticulture greenhouses.

Priming Treatment	Emergence (%) Days 3	7	14	21	28
			Echinacea purpurea		
9 days in 50 mM potassium salt at 15°C (59°F)	0 a[z]	34 a	44 a	47 a	47 a
9 days in ddH_20 at 15°C (59°F)	0 a	14 ab	28 ab	32 ab	32 ab
1 day in 50 mM potassium salt at 26°C (79°F)	0 a	19 ab	34 ab	40 ab	40 ab
1 day in ddH_20 at 26°C (79°F)	1.0 a	10 b	24 ab	27 ab	32 ab
No priming	0 a	6 b	16 b	20 b	21 b
			Corepsis lanceolata		
6 days in 50 mM potassium salt at 15°C (59°F)	8 a	28 a	36 a	38 a	39 a
6 days in ddH_20 at 15°C (59°F)	8 a	33 a	40 a	41 a	43 a
3 days in 50 mM potassium salt at 26°C (79°F)	3 a	32 a	38 a	41 a	43 a
3 days in ddH_20 at 26°C (79°F)	1 a	31 a	36 a	38 a	39 a
No priming	0 a	24 a	34 a	36 a	37 a

[z]Means within a column for each species with the same letter are not statistically different (P = 0.05) according to Student-Newman-Keuls' (SNK) test.

Table 2. Effects of priming on seed emergence of *Echinacea purpurea* and *Coreopsis lanceolata* at Buell's Inc. greenhouses.

Priming Treatment	Emergence (%) Days 3	10	17	24	31
			Echinacea purpurea		
9 days in 50 mM potassium salt at 15°C (59°F)	10 a[z]	78 a	84 a	84 a	84 a
9 days in ddH_20 at 15°C (59°F)	2 a	75 a	85 a	85 a	85 a
1 day in 50 mM potassium salt at 26°C (79°F)	2 a	90 a	92 a	92 a	93 a
1 day in ddH_20 at 26°C (79°F)	1 a	85 a	88 a	88 a	88 a
No priming	1 a	76 a	79 a	80 a	80 a
			Corepsis lanceolata		
6 days in 50 mM potassium salt at 15°C (59°F)	8 a	12 a	30 a	42 a	48 a
6 days in ddH_20 at 15°C (59°F)	8 a	14 a	30 a	41 a	43 a
3 days in 50 mM potassium salt at 26°C (79°F)	8 a	17 a	34 a	50 a	52 a
3 days in ddH_20 at 26 °C (79°F)	8 a	16 a	40 a	52 a	59 a
No priming	8 a	8 a	32 a	44 a	52 a

[z]Means within a column with the same letter are not statistically different ($P=0.05$) according to Student-Newman-Keuls' (SNK) test.

High temperature and adequate moisture are the most critical factors affecting emergence during plug production (6, 11). Koranski (10), working with plugs of *Impatiens* cultivars, found that emergence increased with temperature, with the greatest emergence percentage occurring at 30°C (86°F) and the lowest occurring at 17°C (63°F). Laboratory studies testing the effects of temperature on primed seeds of *C. lanceolata* and *E. purpurea*, however, showed that priming improved germination percentages of both species across a broad temperature range of 15°C (59°F) to 30°C (86°F) (15, 16). Samfield's (15) greenhouse studies resulted in emergence percentages as great as 71 and 79% for primed seeds of *C. lanceolata* and *E. purpurea*, respectively; at greenhouse temperatures of 23°C (73°F) day/18°C (64°F) night. Average day and night temperatures in the TAMU greenhouse during the first experiment (26°C-79°F day and 18°C-64°F night) were similar to those of Samfield's, a fact indicating that temperature may not be the only factor responsible for the poor emergence responses of all treatments at TAMU.

Working with seeds of *Impatiens* cultivars in plugs, Karlovich (9) found that when seeds were buried, post-germination activities relating to oxygen availability in the soil medium were more of a problem for emergence than was temperature. Available oxygen is crucial to emergence because of its importance during the pregermination (LAG) phase and because of its effect on seedling emergence after radicle emergence (9). During the first experiment at TAMU, plugs were clearly saturated beyond a point conducive to either germination or seedling development. The amount of mist collected at the emitter heads at TAMU was less than that at Buell's Inc., but the pressure was lower (10 PSI compared to 60 PSI), and the applications were more frequent (every 6 min compared with every 32 min). The greater moisture at TAMU may have resulted in a higher volume of water that actually landed on the flats with less drainage time and thus resulted in less oxygen becoming available for emergence or seedling growth. Results from this first experiment in part support previous research showing that priming has the ability to improve germination and seedling emergence under environmental stress conditions such as extreme temperatures or saturated soils (4, 8, 15, 16). This was so only for *E. purpurea* at TAMU, where conditions were suboptimal. When greenhouse conditions are optimal or close to optimal, as at Buell's, the benefits of priming on emergence are not as obvious because emergence for all treatments is high.

The second study indicates that priming did not significantly affect growth of seedlings, with the exception of root development for both species (Table 3). There were 44 and 51% increases in total root area of *E. purpurea* plugs from ddH_20− and potassium salt-primed seeds, respectively,

Table 3. Effects of priming on plug growth of *Echinacea purpurea* and *Coreopsis lanceolata* at day 28.

Priming Treatment	Leaf length (mm)	Root length (mm)	Shoot area (cm^2)	Root area (cm^2)	Shoot weight (mg)	Root weight (mg)	Survival (%)
				Echinacea purpurea			
Primed in 50 mM potassium salts	25 a[z]	51 a	7.51 a	.82 a	22.64 a	3.56 a	80 a
Primed in ddH_20	24 a	50 a	7.42 a	.78 a	21.98 a	3.36 a	78 a
No priming	22 a	53 a	6.27 a	.54 b	18.54 a	2.68 b	59 a
				Coreopsis lanceolata			
Primed in 50 mM potassium salts	49 a	77 a	8.67 a	1.98 a	25.08 a	4.70 a	61 a
Primed in ddH_20	47 a	75 a	8.62 a	1.48 ab	24.55 a	4.78 a	54 a
No priming	43 a	78 a	7.03 a	1.07 b	18.10 a	3.61 a	54 a

[z]Means within a column with the same letter are not statistically different ($P=0.05$) according to Student-Newman-Keuls' (SNK) test.

compared with plugs from nonprimed seeds. This increase in root area was also reflected in root dry weight, with plugs from primed seeds having significantly greater root dry weights than plugs from nonprimed seeds. Trends were similar for plugs of *C. lanceolata*, with an 85% increase in root area due to priming in potassium salts compared with no priming.

The more rapid root development of plugs produced from primed seed may be a significant response even if other growth responses are not significantly different. In the initial stages of development, perennials invest more energy and resources in the development of root systems than that of vegetative or reproductive parts (1, 3, 5). In plug systems, more developed root systems should make transplanting easier (2, 7), and may result in a more positive growth response after transplanting (11).

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