Seed Priming for Improved Germination in Herbaceous Perennial Plants

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Seed germination is an important component for the efficient production of annual and many herbaceous perennial plants. The high cost of greenhouse production, coupled with the increasing expense of seed, make techniques for increased germination efficiency an important consideration for the greenhouse manager. There is a trend for increased seedling plug production for herbaceous perennials which demands high seed germination. A demand which can sometimes be difficult to achieve considering that many herbaceous perennials have not been subjected to the same breeding selection and seed quality considerations as annual plants (i.e. petunia).

Seed priming is a seed pre-treatment which can significantly enhance germination efficiency in a diverse group of seed-grown plants including agronomic, vegetable and flower crops (Bradford, 1986; Finch-Savage, 1991). In some cases, germination percentage can be improved by seed priming This is particularly evident for poor quality seed lots or seeds germinated under less than optimum environmental conditions (Bradford, 1986). However, for greenhouse production, the primary benefit of seed priming is in uniformity and speed of germination. This is illustrated in Figure 1 for the germination rate of primed compared to untreated purple coneflower (*Echinacea purpurea*) seed. Seed germination commences earlier

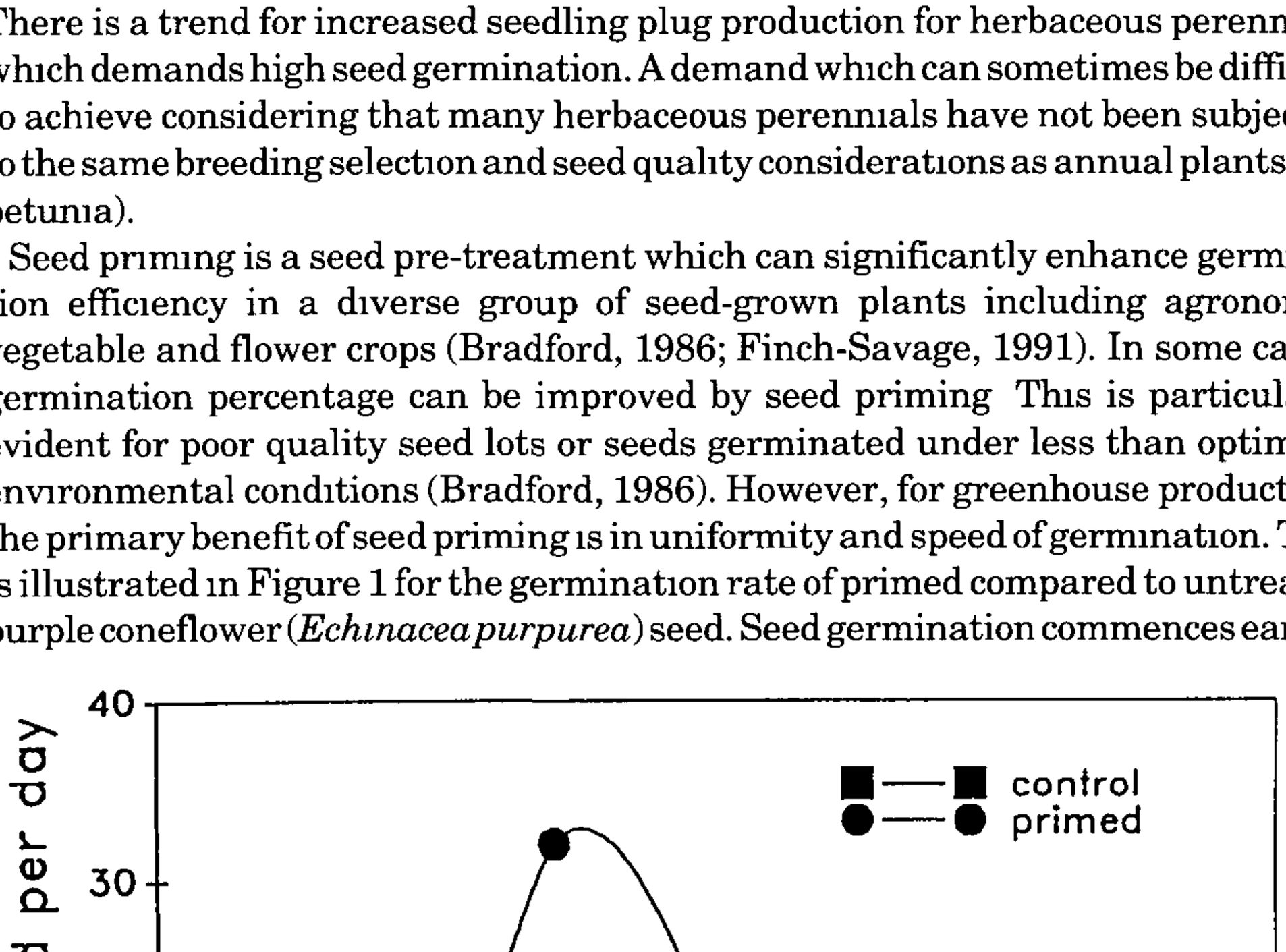

Figure 1. Germination rate in primed compared to untreated control seed of purple coneflower

in primed seed and proceeds in a highly desirable, uniform fashion. Radicle emergence is complete between 2 and 4 days of germination. This translates into a shorter period of time required for seeds to be in specialized germination chambers and for a more uniform crop in the greenhouse

Seed priming can be accomplished in several ways. Seeds may be imbibed in an osmotic solution containing various salts or polyethylene glycol (PEG). This is termed osmotic priming or osmoconditioning A second technique uses the matrix potential properties of vermiculite or several calcined clays to treat seed by solid matrix priming or matriconditioning. This is a newer technique which has shown potential for large seeded crops like soybean and sweet corn (Parera and Cantliffe, 1991). A third technique is low temperature priming. Low temperature priming is usually combined with osmotic seed priming Usual temperatures are 10 or 15°C coupled with osmotic potentials of -5 to -15 bars depending on the species being treated (Bradford, 1986).

Regardless of the seed treatment used to prime seed, the basic concept behind priming is the same. Priming uses osmotic or matrix forces optimized for a particular temperature to hold seeds in the lag phase of water uptake during germination. Figure 2 illustrates the typical phases of water uptake associated with germination. Following the rapid water uptake characteristic of imbibition, there is a period of time where water uptake cannot increase until physiological changes have occurred within the seed. This lag phase prepares the seed for radicle emergence. The seed is irreversibly committed to germination once it has entered this phase of water uptake associated with radicle emergence The seed will not survive if it experiences drying during the phase of radicle emergence. However, the seed can be dried during the earlier lag phase of germination without detrimental results. *Primed seeds are held in the lag phase for 1 to 15 days to allow the*

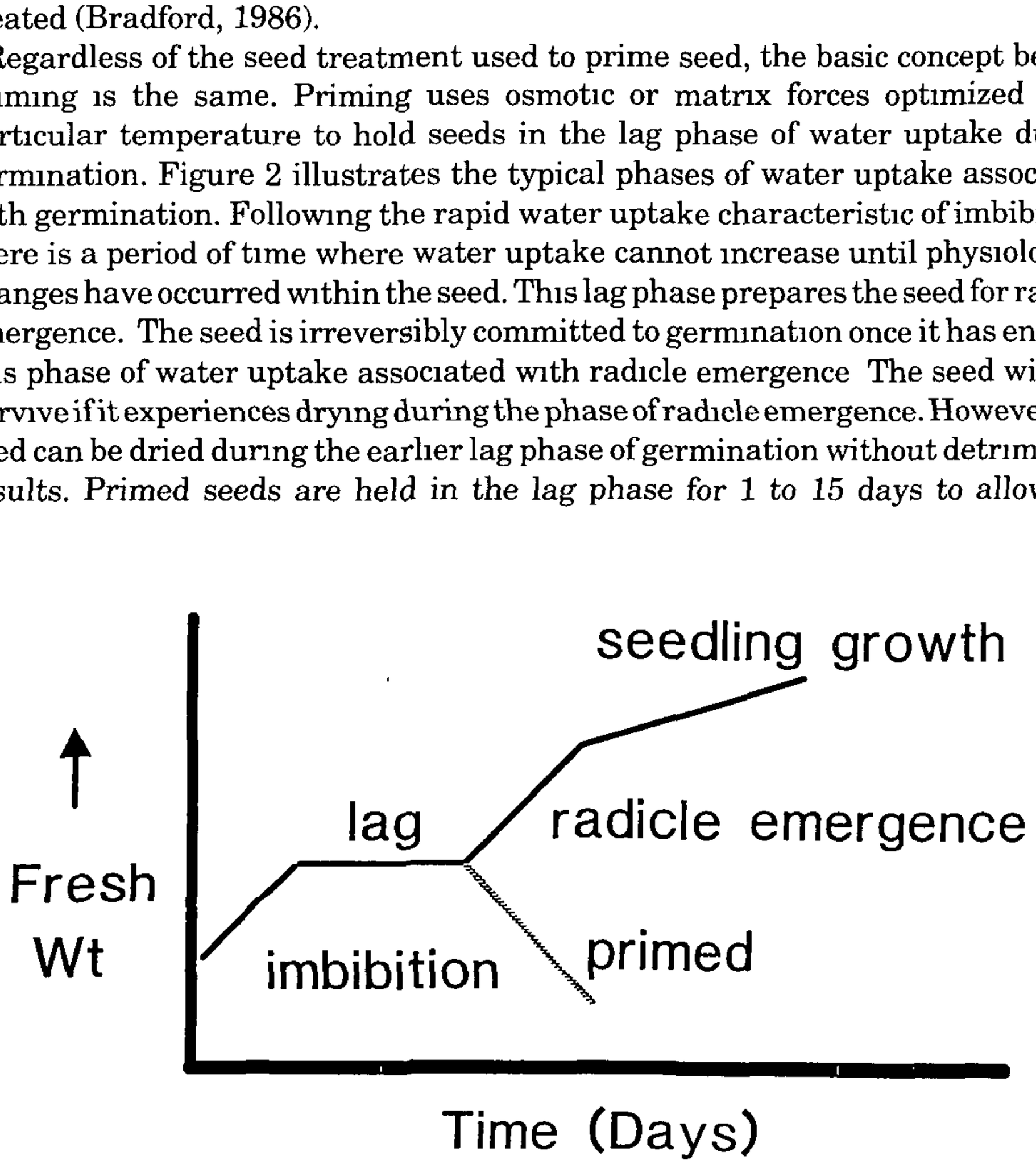

Figure 2. Schematic representation of uptake water the phases of uptake during seed germination

physiological changes within the seed to proceed while the seed remains uncommitted to germination. After primed seeds have been dried back to about their original moisture content, the seeds have become "invigorated" (Heydecker et al., 1975) and will subsequently display superior germination characteristics

The optimum priming treatment can vary between species or even seed lots (Heydecker, 1977). Osmotic priming has been the technique most extensively studied and is being used commercially by several seed companies for vegetable and annual flower seed. To my knowledge, there are no seed companies currently offering primed seed for herbaceous perennials However, the technique of seed priming is not difficult and perennial growers may wish to experiment with priming to gauge the potential benefits priming may have to their production schemes.

There are three basic parameters to be considered for devising a protocol for osmotically priming a particular seed lot. These are the priming temperature, osmotic potential of the priming solution and the length of time the seeds are treated in the priming solution. The preliminary experiments you develop for testing priming protocols should include a temperature range from 10 to 25°C, priming solutions with PEG 6000 (also sold as PEG 8000) from -5 to -15 bars (200 to 350 grams added slowly to a liter of water) and a priming duration of 5 to 15 days. You may want to start with a standard priming protocol of 15°C -10 bars (PEG 6000 at 270 grams in a liter of water) and prime for 10 days. This may indicate to you if seed priming deserves your further attention and whether you should invest in the effort to fine tune a priming protocol

The seed priming protocol we use for purple coneflower seed is indicative of a technique for priming small amounts of seed which could be adapted to your conditions Up to 1000 to 3000 seeds can be primed in a 500 ml priming solution. Less seed should be used for large seeded crops because excessive water removal from seed imbibition can change the concentration of PEG in solution. Seeds can be primed in 750 to 1,000 ml Erlenmeyer flasks or Mason jars. Seeds may simply be submerged in the solution, but we prefer to loosely pack the seed into a cheesecloth sac suspended in the solution. Aerating the solution is essential for optimal priming results This can be accomplished by placing a glass tube two-thirds of the way into the solution and bubbling air through the tube. One bubble per second is an adequate rate. Air can be delivered from a compressed air tank through the proper regulator or the room air (if it is clean) can be circulated through the solution with an aquarium pump Place an air export tube into the lid of the container, but otherwise have the container closed to avoid water evaporation from the solution. Clean and sterilize the priming container and bubbling tube between uses to avoid the potential for carryover pathogen problems.

Following priming, the seeds should be rinsed free of the osmotic solution and dried quickly at room temperature by forcing air over a single layer of seed placed on a paper towel. Do not heat seeds to dry them. Seeds should dry down to approximately their original dry weight (within 5%) This should be checked by weighing the seeds before and after priming. Store seeds in a closed container at 5°C Check the seed weight periodically to make sure seeds have not absorbed any water during storage. Germinate seeds soon after priming (within six months) The results for three seed priming protocols for purple coneflower are presented in Table 1. The results are presented as a percentage improvement in germination percent or rate for primed seed compared to untreated control seeds. Four

Table 1. Improvement in seed germination percentage and rate for seeds from four seedlots of purple coneflower treated by several priming protocols

Seed priming protocol			Seedlots							
Duration	Osmotic potential	Temperature	Germination (%)				Germination rate (%)			
(Days)	(Bars)	(°C)	P_1	P_2	B_1	B_2	P_1	P_2	B_1	B_2
4	-5	25	5[z]	39	3	48	37	106	46	375
10	-10	15	13	76	20	73	65	236	78	130
20	-15	10	16	55	25	67	170	683	238	263

[z]Percent improvement in germination for primed seed compared to the control

commercial seedlots were treated and included two seedlots of open pollinated purple coneflower designated P_1 and P_2 and two seed lots of the cultivar 'Bright Star', designated B_1 and B_2. Two of the seedlots (P_1, B_1) were high quality seed lots and displayed only a small improvement in germination percent. However, all seed lots showed a substantial improvement in germination rate over untreated control seed Similar results (especially in germination rate) have been shown for vegetable and annual flower seed and should be expected for many herbaceous perennial crops However, *the added cost of handling primed seed may preclude many seed* companies from priming the low volume of perennial seed offered by their companies. This means that the added advantages of primed seed for herbaceous perennial crops may only be experienced by growers willing to experiment with this technique for themselves.

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