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Rate of Germination and Seedling Growth of Perennial Ryegrass Seed following Osmoconditioning

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Additional index words. *Lolium perenne,* polyethylene glycol, turfgrass

Abstract. **This study evaluates the effects of seed osmoconditioning on germination and seedling growth of perennial ryegrass *(Lolium perenne* L.). Seeds were osmoconditioned in polyethylene glycol 8000 with water potentials ranging from 0 to -1.4 MPa for 48 hours. Osmoconditioning for this crop at -1.1 MPa resulted in a 35% germination increase after 48 hours under optimum (15/25C) germination conditions. This promotive effect was observed until 104 hours for percentage germination and root growth and 118 hours for shoot growth. Rate of seed germination and seedling root growth of osmoconditioned seeds also was enhanced when seeds were placed under suboptimum germination temperatures of 5, 10, and 15C. These results suggest that while osmoconditioning enhanced initial germination rate and seedling root growth under laboratory conditions, it did not do so under prolonged favorable conditions. However, the promotive effects of osmoconditioning were more beneficial when seeds were exposed to less favorable germination conditions.**

Pregermination employs the planting of seeds that are partially germinated before being sown and is effective in shortening the germination period, providing a significant advantage for turf situations encountering heavy traffic such as athletic fields (Dudeck and Peacock, 1986). Difficulties with pregerminated seed include the need for immediate planting after treatment and problems with uniform seed dispersion because of high seed moisture content (Mellor et al., 1986). In addition, field studies using pregerminated seeds have been less successful for rapid-germinating seeds such as ryegrass *(Lolium* spp.) compared with slow-germinating seeds such as Kentucky bluegrass *(Poa pratensis* L.) (Lush and Birkenhead, 1987).

Osmoconditioning is an alternative seed treatment that preconditions seeds in a solute or osmoticum that regulates water activity to enhance rapid germination (Heydecker et al., 1975). After seed hydration, seeds are dried to. a moisture content that permits safe seed storage and routine handling. Osmoconditioning reduces germination time and enhances uniformity of emergence of diverse crops (Bodsworth and Bewley, 1981; Khan, 1977; Liptay and Tan, 1985). One study has considered the effect of priming on annual ryegrass *(Lolium rigidum* 'Winimera'), which resulted in an initial enhancement in germination (Lush et al., 1981). The purpose of this study was to evaluate the effect of osmoconditioning on the germination rate, seedling growth, and cold tolerance of perennial ryegrass seeds.

'Prestige' (International Seeds, Hasley, Ore.), 'Pennant' (E.F. Burlingham & Sons, Forest Grove, Ore.), and 'Prelude' (Lofts Seed, Albany, Ore.) ryegrass were used for this study. All germination studies were conducted with 50 seeds placed on germination blotters (Anchor Paper, St. Paul, Minn.) moistened with 10 ml test solution in 105 x 105 x 40 mm (width x length x depth) clear plastic germination boxes. Germination studies were conducted at alternating 15/25C (16/8 h) in constant light for 14 days as recommended by the Rules for Testing Seeds (Assn. of Official Seed Analysts, 1989). Seed moisture values were expressed on a fresh weight basis and determined by drying the seeds in a forced-air oven at 104C for 24 h.

Seed moisture uptake in water was assessed by soaking the seeds, as described above, for 3, 6, 12, 24, or 48 h at 22C. Seed moisture uptake in polyethylene glycol (PEG) 8000 (Sigma, St. Louis) and germination were evaluated in various concentrations of PEG, with values corresponding to water potentials of -0.1, -0.2, -0.4, -0.7, -1.1, and -1.4 MPa as reported by McDonald et al. (1988). Seed moisture content expressed as fresh weight content was determined after 48 h. Seeds were placed in each water potential and germination counts made at 14 days. Each soaking duration treatment was replicated three times.

The effect of osmoconditioning on seed germination and seedling root and shoot length was evaluated following osmoconditioning of seeds in PEG at -1.1 MPa for 48 h. After osmoconditioning, the seeds were washed briefly with double distilled water to remove surface residue PEG and then air-dried at 22C for 48 h. Seed moisture content (103 g H_2O/kg fresh weight) following air drying of the osmoconditioned seeds did not differ significantly (P = 0.05) from the nontreated control. After air-drying, seeds were germinated as described above, and germination and root and shoot length determined at 56, 84, 104, and 118 h. The effect of osmoconditioning on germination and root growth at suboptimal germination temperatures was also determined. Seeds were osmoconditioned as described above in PEG at -1.1 MPa and germinated at 5, 10, or 15C. Percentage germination and seedling root lengths were determined at 48, 76, 96, and 168 h.

All 50 seeds from each treatment of the osmoconditioning study were evaluated. The experiments were repeated once. The data were combined for all perennial ryegrass cultivars since no difference (P = 0.05) among cultivars was detected.

Moisture uptake of perennial ryegrass seeds soaked from 0 to 48 h in water was rapid during the first 12 h soaking and plateaued at 500 g H_2O/kg fresh weight after 24 h (Fig. 1). Varying water potentials using PEG as an osmoticum revealed that germination was depressed by a water potential of -0.4 MPa or less (Fig. 2). This water potential corresponded to a seed moisture content of 430 g H_2O/kg fresh weight. In a similar study, examining Italian ryegrass *(Lolium multiflorum*

Table 1. Percentage germination and seedling root length of perennial ryegrass seeds at 5, 10, and 15C after 48, 76, 96, and 168 h following osmoconditioning at −1.1 MPa compared with untreated control.

	Germination (%)				Root length (mm/seedling)			
Temp/treatment	48 h	76 h	96 h	168 h	48 h	76 h	96 h	168 h
5C								
Osmoconditioned	0	0	17	71	0.0	0.0	0.0	1.3
Control	0	0	0	27	0.0	0.0	0.0	0.0
Paired *t* test	---	---	14.9*	7.4*	---	---	---	3.4*
10C								
Osmoconditioned	13	53	68	94	0.0	0.9	1.7	14.8
Control	0	19	55	91	0.0	0.0	0.1	9.1
Paired *t* test	7.5*	7.8*	8.3*	NS	---	20.5*	7.7*	15.3*
15C								
Osmoconditioned	32	72	87	97	0.0	3.5	5.4	27.6
Control	1	19	73	91	0.0	0.3	2.3	21.3
Paired *t* test	7.3*	5.1*	4.2*	NS	---	20.8*	16.9*	7.0*

NS,*Nonsignificant or significant at $P = 0.05$, respectively.

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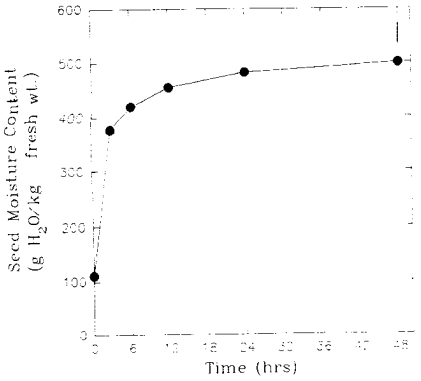

Fig. 1. Seed moisture uptake in water at 22C of perennial ryegrass seeds at various intervals up to 48 h. Bar represents SE.

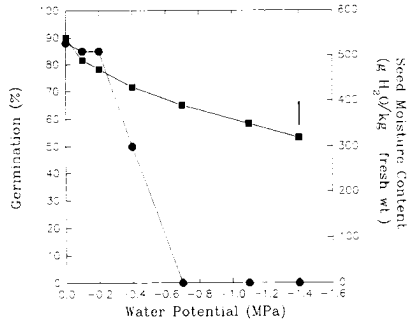

Fig 2. Perennial ryegrass seed germination under optimum (15/25C) conditions after 14 days in several osmoticums and the relationship to seed water uptake. Bars represent SE. ●, Germination; ■, moisture content.

Lam.) seeds, Marshall and Naylor (1985) showed that reduced germination occurred from -0.73 to -1.15 MPa, with coleoptile emergence being more sensitive to reduced water potentials than radicle emergence. However, there was no indication in that study of seed moisture content at these values. We conclude that the critical moisture content necessary for germination of perennial ryegrass seeds is 430 g H_2O/kg fresh weight.

Evaluation of osmoconditioning in differing water potentials that were less than the critical moisture content (-0.7 to -1.4 MPa) demonstrated that -1.1 MPa produced the greatest promotion in germination for both times examined (Fig. 3). Osmoconditioning of perennial ryegrass seeds at -1.1 MPa, compared with the control, resulted in a 35% improvement in germination at 48 h (Fig. 3). These data show that osmoconditioning of perennial ryegrass seeds significantly enhanced the rate of germination and seedling growth under optimum (15/25C) germination conditions.

To determine the persistence of the optimum osmoconditioning treatment for enhancing the rate of germination and seedling growth, a study was conducted to evaluate these characteristics for an extended period. Osmoconditioning at -1.1 MPa produced a 28% increase in germination over the control at 56 h (Fig. 4). But, with time, less difference in percentage germination between the osmoconditioned and control seeds was ob-

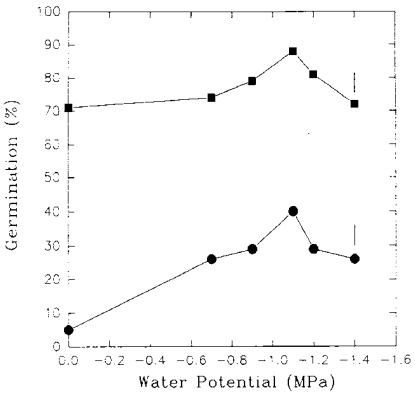

Fig. 3. Perennial ryegrass seed germination at 48 and 72 h under optimum (15/25C) conditions, as affected by preconditioning in several osmoticums. Bars represent SE. ●, 48 h; ■, 72 h.

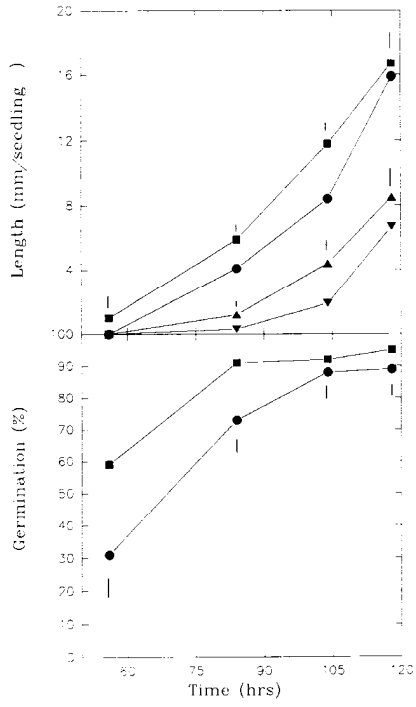

Fig. 4. Germination and shoot and root growth of osmoconditioned (−1.1 MPa) and untreated seeds under optimum (15/25C) conditions as a function of time of germination. Bars represent separate SE for shoots, roots, and germination. (**Top**) ■, osmoconditioned, root; ●, control, root; ▲, osmoconditioned, shoot; ▼, control, shoot. (**Bottom**) ■, osmoconditioned; ●, control.

served until no difference existed at 104 and 118 h. Seedling roots emerged at 56 h for the osmoconditioned seeds, and significant differences continued to be observed until 118 h of soaking. Shoots did not appear until 84 h. Significant ($P = 0.05$) increases in shoot length were recorded for the 84- and 104-h soaking. No difference was observed in shoot length between the treatments at 118 h. These data demonstrate that osmoconditioning of perennial ryegrass seeds accelerates germination and seedling growth. However, the effects are temporary and no differences between treatments for any of the variables monitored were detected after 118 h. Lush et al. (1981) found similar results for annual ryegrass seeds that had been given a hydration-dehydration treatment. Thus, it appears that the stimulatory effect of osmoconditioning is short-lived under optimum germination conditions.

Under less favorable temperature conditions, low germination temperatures (5, 10, 15C) delayed germination and reduced seedling root growth both for osmoconditioned and control seeds (Table 1) compared with seeds evaluated under optimum conditions (Fig. 4). Under the three low temperatures examined, osmoconditioned seeds exhibited a higher percentage of germination (generally up to 96 h) and root growth than control seeds. These data differ from those reported by Lush et al. (1981) who showed that germinability of annual ryegrass seeds was not affected by adverse temperatures following a hydration-dehydration treatment.

Seedling roots emerged at 76 h at 10 and 15C and at 168 h at 5C for the osmoconditioned seeds. Throughout the period of this study, osmoconditioned seeds produced significantly longer seedling roots under cool conditions than control seeds. This improvement in germination and seedling growth through osmoconditioning under low temperatures continued for a longer time than under optimum conditions. These studies reveal that osmoconditioning of perennial ryegrass seeds may be of benefit for turf establishment under salinity or temperature stress.

Osmoconditioning resulted in enhanced perennial ryegrass seed germination and development under cool stressful conditions. This enhancement would benefit spring turf establishment when earlier planting would result in a better turf stand before summer stress periods. Under less stressful or optimum conditions, such as a fall seeding, osmoconditioning would be of little benefit.

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Treeshelter Use in Producing Container-grown Trees

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Abstract. **Treeshelters were used for the nursery production of *Cedrus deodara* Loud. (deodar cedar), *Quercus* ilex L. (holly oak), and *Magnolia grandiflora* L. (southern magnolia) trees growing in 19-liter containers. Air temperature, relative humidity, and CO, concentration were higher inside the treeshelters than outside. Trees grown inside treeshelters were 74% to 174% taller than trees grown without shelters. Trunk caliper of *Magnolia* and *Quercus* was not affected, however, for *Cedrus* trees caliper was larger for trees grown without a shelter. Upon removal of the shelter, *Cedrus* trees were incapable of supporting their own weight. Lateral branch development was inhibited and leaf senescence was greater with *Magnolia* trees grown in a shelter. *Quercus* trees grown in shelters were ready to be transplanted into the landscape. Water use was similar for trees grown with or without shelters. Trees grown in shelters had lower root fresh weights.**

Treeshelters are now used in the establishment of trees in the landscape (Evans and Potter, 1985; Frearson and Weiss, 1987; Potter, 1988). These cylindrical or square, translucent, polypropylene tubes of varying height (usually 60 to 150 cm) are placed around seedlings or transplants at planting time. They increase the survival of newly transplanted trees by reducing weed competition and damage due to browsing animals (Potter, 1988, 1991). Increases in growth have been observed in plants grown in treeshelters. Height increases of 60% to 600% have been observed with cherry and oak seedlings, respectively (Frearson and Weiss, 1987; Potter, 1988). Growth rate increases have been attributed to the enhanced growing environment around the plant achieved with the use of the treeshelter. Increases in ambient temperature, relative humidity, and CO_2 concentration have all been suggested as probable causes for increased growth (Frearson and Weiss, 1987; Potter, 1988). The nature of the relationship among these environmental characteristics and their potential effect on treeshelter-grown plants is not clear.

Treeshelters are intended for and customarily used in the landscape (Potter, 1991). The use of treeshelters during the production of container-grown plants has not been explored. However, based on work conducted with treeshelters in the landscape, plant growth could be enhanced and plants more suitable for transplantation to the landscape could be produced with the use of treeshelters in the nursery. The objectives of our work were to: 1) determine how container-grown, landscape trees would respond to being grown in treeshelters in a nursery, 2) monitor the environment in and around treeshelters used to produce container-grown trees, and 3) determine the water-use characteristics of these trees grown with or without a treeshelter.

Deodar cedar, holly oak, and southern magnolia were selected for the study. In Feb. 1990, 30 young plants of each of the three species grown in 3.8-liter containers were transplanted into 19-liter containers. A treeshelter (Tubex, St. Paul, Minn.) was placed over 10 plants of each species (Fig. 1). The bottom of the shelter was pushed ≈ 3 cm into the container medium. A stake was driven down along side the shelter and the shelter tied to it for support.

All of the plants in the experiment were arranged in east-west rows (50 cm between plants), with the northern- and southern-most rows containing plants without shelters and the center row containing plants in shelters (51 cm between rows). Of the 10 plants of each species in shelters, six were used to monitor the environment in and around the shelter, As a reference, five additional 19-liter containers were fitted with a treeshelter, but had no plant growing in it. Holes were drilled into the five reference and six monitored treeshelters for each species and plugged with septa to facilitate taking gas (CO_2) samples from inside the shelter.

Height and trunk caliper (at the top of the pot) were measured for each experimental plant at the beginning of the experiment and on 12 Dec. 1990. None of the trees were pruned during the experiment. On two occasions (13 Apr. and 27 July 1990) during the growing season, temperature, relative humidity (HI 8564 thermohygrometer; Hanna Instruments, Singapore), and CO, concentration (Horiba PIR-2000 infrared CO_2 analyzer) were measured inside and outside the shelter. Gas samples were taken by inserting the needle of a l-ml syringe through the septum to the inside of the treeshelter. A l-ml sample was then extracted and the syringe was placed in a rubber stopper until the gas sample could be measured on a $C0_2$-O_2 analyzer (Saltveit and Strike, 1989).

Water use measurements were taken twice

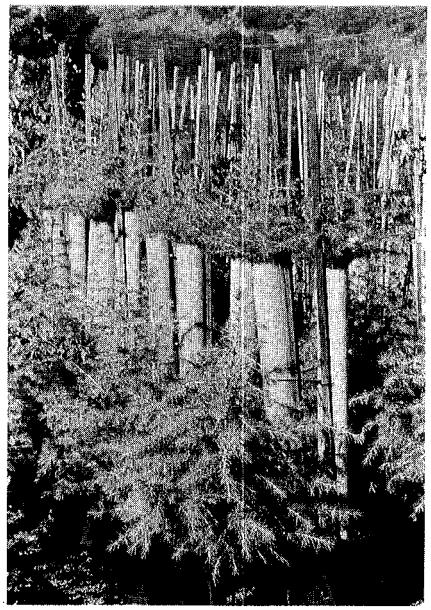

Fig. 1. Physical set-up of the treeshelter experiment (June 1990). Comparison between *Cedrus deodara* trees with and without shelters.

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