Pump Up That Seed: Priming and Pregermination

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Have you ever worried about getting a new green established for a spring tournament? How about renovation of tees or cart path areas during the post or pre-season? Sometimes a helping hand can speed up Mother Nature although its important to know how and why some systems may be more appropriate than others.

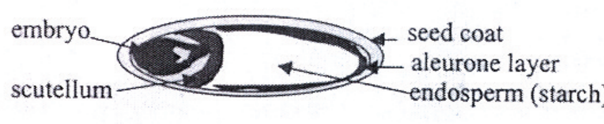
The seed germination time of turfgrasses is based largely on the genetics of each species (Table 1). True, seeds generally germinate faster in the warmer soils of late summer than in cold soils during the spring, while there seems to be relatively little one can do to stimulate germination under a given set of conditions. But golfers don't always wait until a green is agronomically mature before playing on it, and maintaining a decent stand of turfgrass on tees and high traffic areas is a constant battle at many courses.

Seed Germination is a Risky Business

Germination is a tremendous risk for a seed. Once started the process is irreversible. Inside the hard portion of the seed (the caryopsis), a miniature plant exists, complete with the first leaf and the first root (called the radicle) (Fig. 1). The majority of the space inside the grass seed is occupied by a starchy substance known as the endosperm. The endosperm provides energy to initiate growth. Seed germination begins when a seed imbibes (absorbs) water. The water causes the release of hormones from the scutellum (particularly gibberellic acid, or GA). The GA is absorbed by cells in the aleurone layer which then releases enzymes (hydrolases) capable of degrading the starchy endosperm into small sugar molecules. These sugar molecules are absorbed by the scutellum which transfers them to the embryo. The energy in the sugar molecules is used by the embryo to initiate growth - we see this as the emergence of the first root and leaf. At this stage the young plant is said to be heterotrophic, as it relies completely on stored energy rather than making its own energy.

Once the first leaf emerges above the soil and begins photosynthesis, the seedling is said to be autotrophic, that is, able to synthesize energy, in this case from sunlight. Animals, including humans, are autotrophic because we must consume other organisms for the energy they contain rather than producing our own energy. Only green plants and a few microorganisms are truly autotrophic. The seed is truly at risk following imbibition and prior to the development of leaves and roots because, once the starch in the endosperm is used up, the seedling has no other energy source. This is why seeded areas are prone to failure if subjected to intermittent wet and dry periods. Each time the seed or seedling is moistened, more of the enzymes are released from the seed and more of the starch in the endosperm is degraded. When the seed dries, the seedling stops growing and the enzymes disintegrate. Planting the seed too deep can also result in poor establishment. If the enzymes and/or the endosperm are used up before the developing seedling establishes a leaf system above the soil level and begins photosynthesis, the seedling will die.

Fig. 1. Diagram of a Grass Seed



The optimal soil temperature range for germination of cool season grasses is between 60°-85°F. When germination is needed fast under suboptimal conditions several alternatives may be tried. These include soil heating, seed pregermination and seed priming.

Heat that Soil!

Unless you have an in-ground heating system it may seem impossible to heat the soil to aid germination and establishment. If you have ever covered your greens, though, you know how fast the grass under the covers can start growth compared to uncovered grass. The covers help retain solar heat which increases the soil temperature.

Sometimes only a few extra degrees can make all the difference. Covers can also be used to promote establishment from early spring seedings. You do need to monitor the conditions under the cover to ensure the environment does not become unfavorable for the grass (too hot, too dry) or promote diseases (e.g., Pythium). Temperature is easily monitored with an inexpensive soil thermometer. If the temperatures or humidity levels become high, the covers can be temporarily pulled back to return to favorable conditions. Black plastic covers heat the soil fastest though any plastic, black or clear, can quickly result in high humidity and free moisture levels that favor fungal diseases. If plastic is used, punch holes in it to allow air movement and water penetration. Geotextile blankets may also be used, as well as Typar or Reemay. Be aware that

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Table 1. Germination requirements of cool season turfgrasses (adapted from Christians, 1998)

Species	Species (Scientific name)	Days to Germinate
Creeping bentgrass	*Agrostis palustris*	6-10
Colonial bentgrass	*Agrostis capillaris*	7-14
Kentucky bluegrass	*Poa pratensis*	6-28
Supina bluegrass	*Poa supina*	unpublished, faster than P. pratensis
Rough bluegrass	*Poa trivia lis*	6-21
Perennial ryegrass	*Lolium perenne*	3-10
Tall fescue	*Festuca arundinacea*	4-12
Creeping red fescue	*Festuca rubra*	5-12
Hard fescue	*Festuca longifolia*	5-12
Chewings fescue	*Festuca rubra commutata*	5-12

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any cover which prevents sunlight from penetrating (especially black plastic) can stop seedling growth following germination unless removed immediately prior to or at time of germination.

High intensity discharge (HID) lamps may be useful to aid soil heating when sunlight is insufficient. Metal halide or high pressure sodium lamps are the most readily available because they are used in the greenhouse industry. Depending on their wiring, either 110 or 208/220 volts may be required. Oakland Hills Country Club used lamps (borrowed from a university) to help germinate a new seeding of creeping bentgrass in preparation for the 1996 U.S. Open.

What's the difference between seed priming and pregermination?

The difference between seed priming and pregermination is basically a matter of time and stage of germination. Pregermination uses seed which has been brought to the point of germination while primed seed has imbibed some water but has not undergone all the steps necessary for germination. You can tell when pregerminated seed is ready because some of the seed has a little white fuzz on it which, on closer inspection, is not mold (hopefully!) but small roots with abundant root hairs. Pregermination can be performed using the following steps:

1. Place up to 50-100 Ibs. seed in a 55 gal. drum. Smaller vessels can also be used.

2. Fill the drum with sufficient water to completely cover the seeds. A few seeds (up to several hundred) may float on top, don't worry about these.

3. Stir the seeds for a minute or two to expose all seeds equally to the water and oxygen. Leave uncovered at room temperature (60-70 F).

4. Replace the water daily (each 24 hour period). This removes seed germination inhibitors which have been secreted from the seed coat. Don't worry if a little water is left in the barrel during replacement as it will be diluted by the fresh water. Use room temperature water for best results. Don't forget to stir the seeds at least once a day.

5. Repeat steps 3-4 for at least two days, three to four days at most. Species which have slower germination rates will require more time than species like perennial ryegrass which have rapid germination rates. The water temperature and a few other variables may affect the length of soaking required.

6. The seed on a firm surface which will allow excess water to dissipate (e.g., a concrete slab). Let the seed dry slightly, but not completely, to facilitate spreading. If you are not ready to seed immediately, mist the seed as needed to keep it moist. You may keep the seed in this manner for a few days at most. Once you see the white roots beginning to emerge from some of the seed, plant all the seed immediately. Otherwise you are likely to end up with a mass of root-entwined seeds which cannot be spread.

7. Plant the seed immediately. Mulch as appropriate. You will need to keep the seed moist. Since the seed is moist during the spreading operation, this step can be challenging since moist seed tends to stick to spreaders. Sometimes the seed can be mixed with solid carriers such as sand, corn cob particles, or organic fertilizers. The best method is to use a hydraulic seeder. If a hydraulic seeder is used, set the agitation at or slightly below normal. Do not set the agitation so high that any emerging roots are sheared from the seeds as these will not regrow very well, if at all. To facilitate emptying water from the drum, cut the bottom off the drum before

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use. Invert the drum and use the top with the spigot on it to drain the water from what is now the bottom of the container. Fine mesh screen can be placed inside the drum to prevent the seed from flowing out of the spigot.

8. An aquarium aerator can be used to ensure good oxygen supply.

Seeds are living tissues and cannot survive without oxygen for respiration. Seed priming follows the same basic principle as pregermination but the process stops short of any roots or shoots actually breaking out of the seed coat. Osmoconditioning agents which control the rate of water uptake are generally considered necessary for "true" seed priming (Danneberger et aI., 1992). Osmoconditioners include polyethlyene glycol (PEG) or various salts (including table salt). Because the osmotic potential of the solution, temperature, light and air need to be closely monitored for best results, seed priming is often best left to industry. If you are a do-it-yourselfer, you can try the following steps (Brede, 1989):

1. Prepare a solution of 1 Ib salt per 10 gallons water.
2. Spread a layer of seed on a hard surface (concrete or plastic sheet) and thoroughly wet the seeds.
3. Turn the seeds over several times each day.
4. Once each day, drain the seeds and replace with fresh salt solution.
5. Rinse the seeds with fresh water after seven days of treating with the salt solution and allow the seeds to air dry.
6. Plant the seeds using your regular equipment. Alternatively, the seeds can be temporarily stored in a refrigerator (up to three or four weeks).

Some people who have tried this technique suggest the above rather than letting the seeds soak in a solution for several times, probably because it limits the amount of seed which is brought to the "pregermination" or "germination" stage. Some techniques call for soaking the seed in the solution for a few days with an aerator to provide oxygen to the seed.

A number of additives have been evaluated for their effects on seed priming with mixed success. Detzel (1994) found that wetting agents, sulfuric acid seed scarification, and seaweed extracts either had no effect or decreased the percent germination and increased the germination time. Sometimes water soluble fertilizer sources seem to enhance the effects of priming although some may also be toxic (potassium nitrate).

Other techniques have been developed such as solid matrix priming and the drum priming methods. Solid matrix priming uses solids with specific water holding properties to control the amount of water available for seed uptake (e.g., Micro-Cell-E, a calcium silicate compound). Several years ago a British company (Horticultural Research International, Wellesbourne, England) patented the drum priming method in which water availability is controlled by physical means. Seeds are placed in a rotating drum and water is introduced in small amounts from holes in the drum as the drum passes over and through a shallow layer of water (Tryon, 1994).

Both pregermination and priming can allow for quicker establishment than seed from the bag, but results are generally most noticeable during cooler than optimal temperatures. Results are most impressive with slower germinating species (e.g., Kentucky bluegrass) and least noticeable with faster germinating species (e.g., perennial ryegrass).

Primed seed has three advantages over pregerminated seed:

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1) Since it hasn't actually germinated, you don't have to worry about breaking off the roots or shoots which have emerged on some seeds,

2) It can be air-dried and temporarily stored (usually under refrigeration) before use, and

3) Since the seed surface is dry, the seed is easier to spread uniformly compared to pregerminated seed. Pregerminated seed, however, is more likely to give a faster stand of turfgrass than primed seed since it is further along in the developmental process, although primed seed can still sometimes give faster results than untreated seed. With pregerminated seed it is critical to maintain a moist seedbed to prevent desiccation.

Because seed priming and pregermination can be more of an art than a science, and the seed from either process has only a limited shelf life, many companies have worked to perfect a commercially successful seed priming process. Unfortunately the results have not been as successful as initially anticipated. Several years ago I evaluated one company's novel priming methods which were designed to allow primed seeds to be stored for extended periods (6-12 months) at room temperature. The test used Kentucky bluegrass 'NuBlue'. I compared the company's treatments against seed I primed myself (in ordinary water for four days) and untreated seed. On August 4, 1995, twenty-five seeds from each treatment were planted in a pot containing a pasteurized spaghnum peat:perlite greenhouse mix. Each treatment was replicated four times. The pots were placed in a greenhouse and monitored at two to five day intervals for germination and subsequent growth (height and clipping yields). Air temperature highs ranged from 86-90 F for the first week and from 79-84 F for the duration of the study. Pots were misted three times daily for five minute intervals to maintain moist soil. The germination results are summarized below (Table 2). Although not all treatments are listed, the treatments shown include the entire range of results.

Table 2.
Effect of long term shortage on germination of primed Kentucky bluegrass seed

Treatment	5 days*	10 days*	17 days*
Control (untreated)	25	73	76
Recently primed	46	70	80
Test treatment # 1	18	78	82
Test treatment # 2	14	59	6
Test treatment # 3	29	69	79
LSD (0.05)	15	14	12

The results from my particular study showed seed priming (or soaking, since the water did not contain any osmoticum) followed by one day of drying at room temperature before planting performed better than any other treatments. The effect was temporary, as most of the treatments, included the untreated seed, caught up within 10 days of planting. Of course, the results may have been different if the temperatures were colder than optimum rather than above the optimum, but the results do show that a fair degree of fast establishment can be achieved with minimal effort compared to seed from the bag. If time is not limiting, though, there is probably little need to consider seed priming or pregermination.