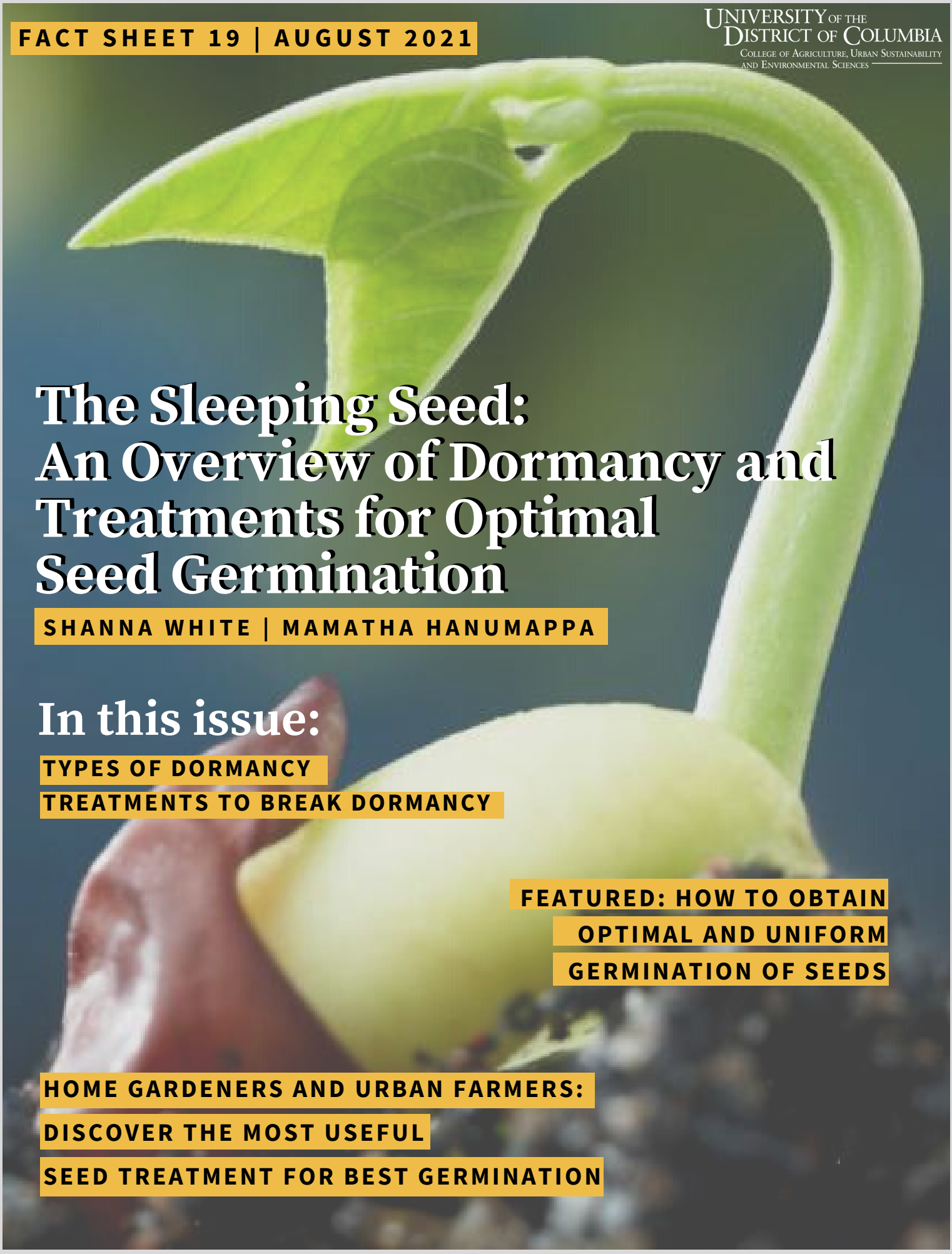
FACT SHEET 19 | AUGUST 2021

UNIVERSITY OF THE DISTRICT OF COLUMBIA
COLLEGE OF AGRICULTURE, URBAN SUSTAINABILITY AND ENVIRONMENTAL SCIENCES



The Sleeping Seed: An Overview of Dormancy and Treatments for Optimal Seed Germination

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HOME GARDENERS AND URBAN FARMERS: DISCOVER THE MOST USEFUL SEED TREATMENT FOR BEST GERMINATION

Dormancy is a biological condition where a viable and healthy seed does not germinate even under the right conditions. These conditions may be ideal but do not necessarily allow the seeds to flourish. For example, if seeds germinate during a few warm days in winter, seedlings are unable to survive when the temperature goes down again. Dormancy is an evolutionary trait that helps seeds survive unfavorable conditions. While this control over germination is helpful for plant survival in the wild, it can prevent uniform germination, which is desirable in crop production. Dormancy may be caused by internal or external factors, or a combination of both, a condition known as double dormancy. There are four environmental factors that create the conditions required for germination: light, water, oxygen, and temperature. Understanding the factors that cause dormancy and the conditions required for germination can help in figuring out which methods to use to break dormancy. One way is to consider the habitat of a species, which can give insight into treatments that can induce germination. Dormancy can be broken by replicating the germination conditions of the seed's native habitat, coupled with physical techniques.

Types of Dormancy

There are two main types of dormancy -- physical (exterior/external) and physiological (interior/internal). Physical dormancy is caused by an impermeable seed coat that prevents water from getting inside the seed. Seeds that have hard, thick seed coats that physically prevent water or oxygen movement into seeds are said to have physical dormancy. In order to start the germination process of physically dormant seed, the exterior seed coat must be penetrable by water. Temperature, scarification, or alternating freezing and thawing cycles can create conditions favorable to the germination of a dormant seed.

Physiological dormancy is commonly found in temperate and arctic native plants. While many of these seeds are permeable to water, internal changes at the hormone level are needed for the seed to germinate. Subjecting seeds to cold and moist conditions (stratification, see below) overcomes physiological dormancy.

In seeds that have a combination of internal and external dormancy, physical dormancy must be broken first, making the seed permeable to water. Then, physiological dormancy can be broken using stratification methods.

Treatments to Break Dormancy

When dormancy is broken, the embryo inside the seed receives a signal to begin the germination process, enabling gardeners to have a head start or to germinate difficult seeds. There are several ways to break dormancy as described in the table.

TREATMENT	DEFINITION	NOTES
SCARIFICATION	Mechanical (filing, sanding, nicking); or applying heat or sulfuric acid	Intentional wounding of the seed coat; it is easy to damage the embryo if not careful.
IMBIBITION	Also known as priming or leaching	Fill container with hot tap water. Allow water to cool and soak for 24 hours but no more than 48 hours.
CHEMICAL*	Hydrogen peroxide; potassium nitrate; sulfuric acid	Moisten substratum with 0.1 to 0.2 percent potassium nitrate solution.
PLANT HORMONE**	Gibberellic Acid	Soak in gibberellic acid or cytokinin (kinetin) solution for 12 to 24 hours. Concentrations vary, and proper precaution is recommended.
MULCHING	Mimic nature's method. Use a container 6-8 inch deep and fill halfway with a quality seed starter mix. Mist the medium and then sow the seeds on damp soil. Cover with a one-inch layer of wood mulch; wait 3-4 months for germination.	This is a time-intensive process.
LIGHT	8 hours under fluorescent lamps	The light should be provided by cool-white fluorescent lamps for at least eight hours daily during the first 36-72 hours of germination. Light intensity varies according to species.

TREATMENT	DEFINITION	NOTES
STRATIFICATION	Moist and cold temperature	Natural: sow in late summer and let sit outdoors in winter. Artificial: roll seed in a moist paper towel, and refrigerate.
LEACHING	Leaching is the removal of inhibitory chemicals from the seed coat by washing the seeds in running water, or soaking seeds (see Imbibition).	Run water over seeds in a container for 12 to 48 hours. For seeds that produce soluble substances, wash in running water, or change the water at least every 12 hours, taking precaution to not wash the seed away.

⁎May not conform to certified organic uses. ⁎⁎ Although cytokinins, ethylene, and brassinosteroids are also known to break dormancy in several species, gibberellic acid is the most commonly used.

Scarification

Scarification is a method to overcome external dormancy. This method mimics seed treatments that happen in nature such as being cracked or softened by fire, temperature fluctuations, passing through the digestive tracts of animals, and abrasion from natural elements to make the seed permeable. Mechanical scarification can include filing, sanding, and nicking to lightly damage the seed coating. A simple and easy technique for smaller seeds is to rub them with a woodblock covered with sandpaper on one side. Some seeds, such as beans, okra, and tomato, have hard seed coats. Though they germinate easily, optimal germination can be achieved through scarification. Because it is easy to damage the embryo, nicking (figure 1) should be done on the side opposite to the hilum, the small scar where the seed was attached to the ovary inside the fruit-- for example, the “eye” of a black-eyed pea. Soak the seeds for periods of a few hours to overnight after nicking, and plant them immediately, as storing may inhibit germination.

Figure 1: Scarifying dormant seeds using a nail clipper (left), sandpaper/sanding block (middle), and a file (right). Photos: cooltropicalplants.com

Dry heat can be used for fire-adapted species. To apply dry heat, seeds are placed in an oven at temperatures ranging from 175-250°F (80-120°C) from a few minutes to 1 hour, depending on the species. This method should be watched closely, as the heat will crack the seed open.

Seeds can also be added to boiling water for just 5 to 10 seconds, and then immediately transferred to a bowl of cold water. That prevents damage to the embryo inside the seeds. Seeds are ready for sowing after being left to sit for 24 hours.

Sulfuric acid can be used on seeds with very thick seed coats. The safe use of sulfuric acid requires the following: **1**) only treat seeds that are dry, and at room temperature; **2**) ensure that proper protective glasses, gloves, and clothing are worn; **3**) always add acid to water, never water to an acid; **4**) make sure your container is acid-resistant (glass, for example); **5**) use a glass rod to stir the seeds; **6**) immerse the container in an ice bath to control heat from a chemical reaction. The thickness of the seed coat dictates how long to leave seeds in the acid bath. Therefore, it is important to research the type of seed coat your species has.

Imbibition or Seed Priming

Dormant seeds use water as a catalyst to become physiologically active and to break out of dormancy. Before seeds can germinate, they must be exposed to water and oxygen. To create an environment where the seeds can germinate, the seeds can be soaked in water for 24-48 hours. That process is known as imbibition or seed priming. It is an important first step before any other dormancy-breaking treatment is given. There are a few methods to prime or activate dormant seeds. An easy way is to fill a glass bowl or jar with hot tap water (about 140-194^{0}F, or 60-90^{0}C), just enough that the seeds are covered, and you can see some are floating (figure 2). Discard the floating seeds, as those are not viable. Let seeds soak in the cooling water for 24 hours, but no more than 48 hours, as it is possible to oversaturate the seeds, which may lead to seed rotting. Imbibition will be evident if you choose to scarify your seeds because the seeds will enlarge as they uptake water. Some species of seeds may need longer soakings than the recommended time. That should only be done if there are specific instructions to do so for that seed. Water should be changed a few times a day. The primed seeds can be prechilled at 40-50^{0}F (5-10^{0}C) for 5-7 days before sowing.

Figure 2: Seeds soaking in preparation for planting. Source:Flickr.com

Chemical

Potassium nitrate (KNO_3), commonly known as saltpeter, can be used to soften the coat of many seeds in order to expedite germination. That treatment is recommended for brassicas, eggplant, peppers, tomatoes, basil, endive, radicchio, and most flower seeds. Dilute ½ teaspoon (tsp) of granular KNO_3 in 1 quart (qt) of water during imbibition. It should be noted that this treatment does not conform to certified organic uses. Dormant seeds can also be treated with hydrogen peroxide (H_2O_2). The seeds are soaked in a 1-3% solution for 5 minutes to 48 hours, based on the hardness of the seed coating.

Plant Hormone

This treatment is primarily used to break internal dormancy. Gibberellic acid (GA_3) is a plant hormone available as a solvent and used at room temperature. Proper precautions should be taken while using the solvent, as it can be poisonous. The concentration and length of treatment are dependent on the species. Follow the general procedure for seed priming, stir the seeds regularly, but do not rinse. After that soaking, they can also be air-dried and stored for short periods if not sown immediately. GA_3 can be purchased from horticultural suppliers. A stock solution of 1,000 parts per million (ppm) is prepared by dissolving 1 milligram (mg) GA_3 in 1 milliliter (ml) distilled water. So, a 100 mg packet obtained from the supplier will be dissolved into 100 ml (about half cup) of water. Most nurseries use 500 to 1,000 ppm but it is best to try different concentrations with small batches of seed if the concentration is not known. To make a 500 ppm solution, either use half the powder or double the volume of water. Another method is to pour the GA_3 solution into an ice cube tray. Then cut unbleached coffee filters into squares and fold each side diagonally. Place the seeds inside the coffee filter and then place the filter with seeds into the wells of the ice cube tray so that the filter acts as a sponge for the GA_3. Let sit for 24 hours at room temperature. Seeds can then be sowed directly or washed before sowing.

Mulching

That treatment can take 3-4 months before germination begins while the microorganisms break down seed coating. While slow, that method mimics the process used in nature. Use a container 6-8 inches deep and fill halfway with a quality seed starter mix. Mist the soil medium and then sow the seeds on the damp soil. Next, cover with a one-inch layer of wood mulch. Do not use redwood or cedar for this application. The best option is old composted wood mulch. If that is not available, a three-inch layer of wood shavings soaked in a water/compost starter solution for three hours can also be used.

Light

Some seeds started indoors will need an application of light to break dormancy. Use fluorescent lights of the cool white variety for eight hours a day during the first 36-72 hours of germination. The seeds that require light should not be covered when sown but merely watered-in. Cover the seeding tray with a plastic or glass cover to keep the soil moist.

Stratification

With that method, seeds are exposed to moisture and cold temperatures to mimic temperate climates. As seen in figure 3, stratification was the process of alternating layers of moist growing mediums and seeds in barrels and then exposing the seeds to winter temperatures. That is known as natural stratification. While the barrel is the historical method, stratification now means the combination of moisture and temperature to break dormancy. Seeds with double dormancy will need a warm, moist treatment to break physical dormancy prior to stratification to break physiological dormancy.

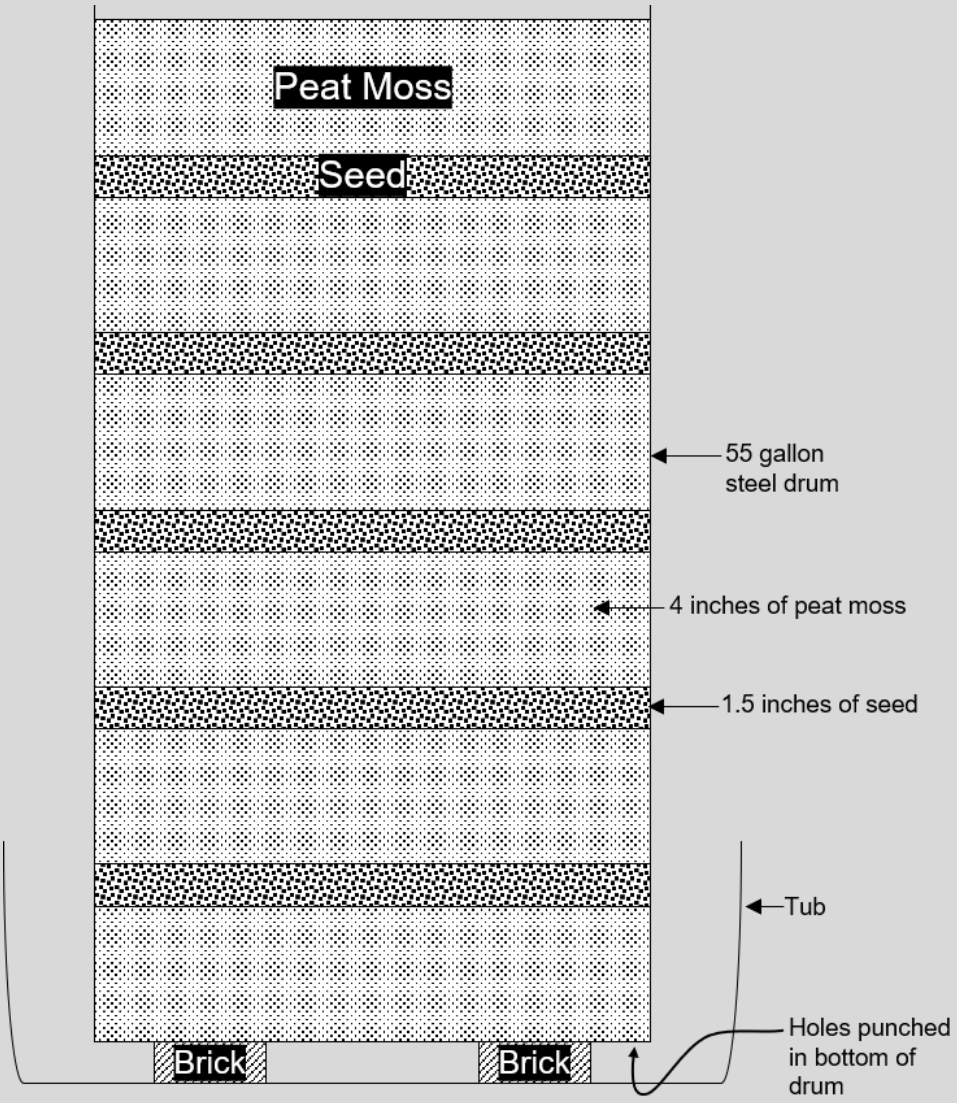

Figure 3: Stratification in a large barrel. Source: *Reproduced from the original by USDA Forest Service*

Artificial stratification is a preferred method since many seeds can be stratified in one place. That can be achieved by mixing seeds with moist sand or peat, or soaking in paper towels, and placing them in a plastic bag or container. The container is then refrigerated for 4-5 weeks, checking for sprouts in between.

For small seed lots, the seeds can be placed on moistened paper towels and rolled (figure 4).

Figure 4: Stratification using a paper towel resulting in the germinated seed. Source: *Garden Gate Magazine*

To try this method, roll seeds into a damp paper towel and place them in a zip-lock bag. Then chill in the refrigerator (about 37-40^{0}F, or 2-4^{0}C) for one week. Check every few days to remoisten the paper towel; should you see sprouts, take them out and plant.

Conclusion:

How seeds are handled, treated, and sown will all have an effect on how the plant will thrive. By understanding dormancy and how to break it, there is a greater chance of successful harvest and the potential for increased crop cycles. For home gardeners and urban farmers, scarification, priming or soaking, and wet paper towel method of stratification are most useful.

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