Some Common Misconceptions About Seed Dormancy©

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INTRODUCTION

Dormancy is a condition where seeds will not germinate even when the environmental conditions (water, temperature, light, and aeration) are permissive for germination (Hartmann et al., 2002). Seed dormancy prevents immediate germination but also regulates the time, conditions, and place where germination will occur. In nature, different kinds of primary dormancy have evolved to aid the survival of a species by programming germination for particularly favorable times in the annual seasonal cycle. Horticulturists apply dormancy-release treatments to facilitate the cultivation of dormant species. The objective of this paper is to describe the major types of seed dormancy and present some of the common misconceptions associated with these dormancy types (Table 1).

MAJOR SEED DORMANCY CATEGORIES

Major seed dormancy categories include:

1) Primary dormancy
    a) Exogenous dormancy
    b) Endogenous dormancy
    c) Combination dormancy
2) Secondary dormancy

Primary Dormancy. This is a condition that exists in the seed as it is shed from the plant. In contrast, secondary dormancy occurs in seeds that were previously nondormant when the environment is unfavorable for germination.

Primary Exogenous Dormancy. Exogenous dormancy is imposed upon the seed from factors outside the embryo including the seed coat and/or parts of the fruit. This type of dormancy is commonly referred to as physical dormancy or hard seeds (Hartmann et al., 2002). Seeds with physical dormancy fail to germinate because the seed is impermeable to water. The outer layer is composed of macrosclereid cells that are responsible for preventing water uptake. Scarification treatments that physically abrade the seed coat or exposure to sulfuric acid are commonly used to alleviate physical dormancy. In nature, exposure to high temperature or extreme fluctuating temperatures is the most likely cause of dormancy release (Geneve, 2003).

Physical dormancy is found in approximately 15 plant families, including Fabaceae, Malvaceae, Cannaceae, Geraniaceae, and Convolvulaceae (Baskin et al., 2000). These seeds usually have a specialized location on the seed (the lens or strophiole) that first becomes permeable to water after dormancy release. Once the seed can imbibe water, it germinates without any further dormancy release treatment.

Primary Endogenous Dormancy. Seeds with endogenous dormancy fail to germinate because of factors within the embryo. These factors can be either physiological or morphological.

Endogenous physiological dormancy can be separated into three types based on their "depth" of dormancy. These include nondeep, intermediate, and deep dormancy (Baskin and Baskin, 1998).

Table 1. Some common misconceptions about seed dormancy.

Misconception	Current knowledge
Physical dormancy is common in plants.	Physical dormancy is only found in 15 plant families. However, the legume family (Fabaceae) is very large and contains many plants with hard seeds. Mechanical dormancy is a type of physical dormancy. The removal of the embryo from the surrounding seed coverings permits germination in most dormant seeds. This indicates that the surrounding tissues present a physical barrier to germination. However, it is felt that this barrier is not the cause of dormancy and factors within the embryo cause an increase in the growth potential of the embryo that allows it to penetrate the seed coverings.
Seeds will stratify if placed dry in the refrigerator.	Stratification will only occur when seeds are above 25% moisture.
After-ripening is a term to describe any dormancy treatment for physiological dormancy.	Originally in the older literature after-ripening was applied to any dormancy breaking treatment that involved periods of warm or cold storage. However, most seed biologists use after-ripening only to describe dormancy release in *dry* warm storage and stratification to describe *moist* warm or cold storage.
After-ripening is a common natural form of dormancy release.	Dormancy loss in temperate climates for seeds with physiological dormancy is most common by warm or cold stratification. However, anytime the seed spends dry (< 20%) and warm will reduce the time required for stratification. Rather than being the primary dormancy release treatment, after-ripening probably functions to modify the seed dormancy state. In desert or tropical environments with extended periods of dry warm conditions, after-ripening can be the primary treatment for seed dormancy release.
Most dormant woody species have deep physiological dormancy.	This type of dormancy only occurs in a few species. The key difference between intermediate and deep physiological dormancy is that the embryo fails to germinate when removed from the seed coverings from seeds with deep physiological dormancy.
Photodormancy is a type of primary dormancy.	Seed biologists feel that light is only a limiting environmental factor for germination similar to temperature and is not a type of dormancy.
Seeds with morphological dormancy that require only warm stratification to germinate are not really dormant.	Seed ecologists consider these seeds dormant because they require more than 30 days to germinate, the embryo fills less than ½ of the mature seed, and the embryo must grow inside the seed before the radicle can emerge.

Double dormancy is the same as combinational dormancy.	Double dormancy was a term used by Barton in 1945 to describe epicotyl dormancy. "Double" refers to the multiple years required for germination. Combinational dormancy occurs in seeds that have physical plus physiological dormancy.
Seeds that do not germinate at high temperatures are in secondary dormancy.	After exposure to high temperature, seeds are considered to exhibit *thermoinhibition* if the seeds will germinate when returned to normal temperatures. In contrast, seeds that will not germinate when returned to normal temperatures are considered *thermodormant*.
Seeds are either dormant or nondormant.	We can only describe dormancy by observing germination. Therefore, if the germination conditions are not favorable the seeds will appear to be dormant. Therefore, in a population of seeds, some may exhibit deeper dormancy than others. Those with shallow dormancy may germinate over a wide range of temperatures, while those with deeper dormancy may not germinate or will germinate only at the optimal temperature. Seed biologists term this conditional dormancy.

Nondeep physiological dormancy is the most common form of dormancy found in seeds. It is alleviated in nature by short periods of warm or cold stratification. They also lose their dormancy after a period of warm, dry storage that is usually called after-ripening. After-ripening is a simple treatment that is applied to many commercial vegetable and flower seeds to relieve dormancy prior to sale to the consumer (Geneve, 1998).

Seeds with intermediate physiological dormancy require up to 12 weeks of cold stratification to alleviate dormancy, while those with deep physiological dormancy require more than 12 weeks. In addition, a major distinction between these two classes of seed dormancy is that the embryos removed from the seed coverings will grow normally from seeds with intermediate physiological dormancy, but isolated embryos from seeds with deep physiological dormancy will fail to germinate or will grow as physiological dwarfs (Flemion and Waterbury, 1945). Seeds of this type ripen in the fall, overwinter in the moist leaf litter on the ground, and germinate in the spring.

A second type of primary endogenous dormancy is morphological dormancy. Morphological dormancy occurs in seeds where the embryo is not fully developed at the time of seed dissemination. Enlargement of the embryo occurs after the seeds have imbibed water and before germination begins. Embryo growth usually occurs by imbibing seeds at warm temperature. Embryo development can take weeks to months to be completed before seedlings finally emerge.

The most complex form of primary endogenous dormancy is displayed by seeds with morphophysiological dormancy (Baskin and Baskin, 1998). These seeds have underdeveloped embryos as is seen in morphological dormancy, but once the embryo fully develops, the seed remains dormant because of a physiological dormancy condition. The simplest example of seeds with morphophysiological dormancy require warm (> 15 °C) temperature to permit embryo growth followed by cold (1 to 10 °C) temperature conditions to break physiological dormancy. The most extreme example is epicotyl dormancy. These seeds have separate dormancy conditions for the radicle and epicotyl. Seeds require a chilling period to relieve radicle dormancy, followed by a warm period to allow the radicle to grow, then a second cold period to release the epicotyl from dormancy. In nature, such seeds require at least two full growing seasons to complete germination. Examples include bloodroot (*Sanguinaria*), *Trillium*, and lily-of-the-valley (*Convallaria*).

Primary Combinational Dormancy. Seeds with combinational dormancy have both physical and physiological dormancy. To relieve dormancy the seed coat must be scarified to permit imbibition, and then exposure to chilling stratification can release the seed from physiological dormancy. This is an uncommon dormancy type found in only a few species including buttonbush (*Ceanothus*), redbud (*Cercis*), golden raintree (*Koelreuteria*), sumac (*Rhus*), and linden (*Tilia*).

Secondary Dormancy. In nature, primary dormancy is an adaptation to control the time and conditions for seed germination. However, if the environment is unfavorable for germination, the seeds may enter secondary dormancy (Khan, 1981). Secondary dormancy can be induced by high temperature, non-appropriate light exposure, or lack of oxygen.

The most common cause of secondary dormancy in nature is from light exposure. Many seeds require light for germination. If a seed is released from endogenous dormancy, but light is unavailable (such as deep burial in the soil) the seed will eventually enter secondary dormancy. This could lead to many years of dormancy cycling where the seed is released from dormancy but forced back into dormancy due to unfavorable light conditions.

Some commercially important species display thermodormancy when the germination temperatures are too high (Geneve, 1998). These include lettuce, celery, and pansy. To avoid thermodormancy, these species are either primed prior to sowing or grown from transplants.

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