第五节 种子休眠及催芽

Seed dormancy and sprouting

Concept

- Dormancy is defined as a physiological state in which a seed disposed to germinate does not, even in the presence of favorable environmental conditions.
- Seeds are able to overcome dormancy and germinate when “triggered” by certain processes that are usually induced by environmental changes.
- Woody species vary tremendously in their degree of dormancy. Some seeds lie in the soil for years before germinating, whereas other are delayed for only a few weeks. The latter condition is sometimes described as “delayed germination” to indicate something less than true dormancy.

种子休眠

具有生命力的种子，由于种皮障碍、种胚尚未成熟或种子存在有抑制物质等原因，在适宜萌发条件下，也不能萌发的现象，称为种子休眠（**seed dormancy**）。

Types of dormancy

- **Seedcoat (or external) dormancy**
- **Embryo (or internal) dormancy**
- **Morphological dormancy**
- **Combined dormancy**
- **Double dormancy**
- **Secondary dormancy**

- 种子休眠类型：
- 一种是由于得不到发芽所需要的基本条件，如水分、温度和氧气等，若能满足这些基本条件，种子就能很快萌发。这种处于被迫情况下的种子休眠，称为强迫休眠，或叫浅休眠。如杨、榆、桑、栎类、油松等种子。
- 另一种是种子成熟后，即使有了适宜发芽的条件，也不能很快萌发或发芽很少，这种情况称为生理休眠，或称深休眠。如红松、白皮松、杜松、椴树等种子。
- 通常所说的种子休眠，实际上是指生理休眠。

休眠原因分析

1、种皮致密坚硬，导致透水性、透气性差；

2、内源激素；

3、种胚未充分发育完全；

4、综合因素。

Seedcoat (or external) dormancy

- Seedcoat dormancy has 3 primary modes of action.

A----In the most common mode, the seedcoats (or other covering structures) are impermeable to the entry of moisture or gases.

for example, acacia, albizia (*Albizia* Durazz.), honey locust, mesquite (*Prosopis* L.), black locust (*Robinia pseudoacacia* L.), sophora (*Sophora* L.)- usually display this characteristic, which is commonly called hardseededness by those who work with seeds

Seedcoat (or external) dormancy

B----The second mode of dormancy action attributed to seedcoats is the mechanical resistance to swelling of the embryo as it absorbs moisture.

This resistance delays full imbibition and emergence of the radicle from within the seed. Mechanical resistance frequently contributes to dormancy and has been documented in big sagebrush (*Artemesia tridentate* Nutt.), pecan, loblolly pine, Korean pine, and water oak. It does not appear to be the primary factor in tree seed dormancy

Seedcoat (or external) dormancy

- **C----**A third possible mode of seedcoat dormancy is presence of germination inhibitors in the seedcoats that may or not play a significant role in dormancy.

  Some of the phenolic substances in seedcoats that may possibly be germination inhibitors could actually be beneficial by inhibiting the growth of pathogenic microorganisms. Some herbaceous species have inhibitors that must leach from the embryo before germination can take place; seedcoats prevent this leaching. There is no conclusive evidence that this condition occurs in seeds of woody plants, but success in stratifying seeds by placing them in porous sacks in running water suggests that it may occur.

Embryo (or internal) dormancy

- The most likely cause of embryo dormancy is the presence of germination inhibitors in the embryonic axis or in the food storage tissues of the seed.
- For germination to occur, these inhibitors must be metabolically inactivated, or their effect must be overcome by germination-promoting substances.
- Germination inhibitors have been isolated and identified in a number of woody plant seeds, with ABA the most common inhibitor.
- Species with ABA functioning as an internal inhibitor include sugar maple, Norway maple (*Acer platanoides* L.), white ash (*Fraxinus americana* L.), apple (*Malus pumila* Mill.), and northern red oak (*Quercus rubra* L.) and English oaks. Other germination inhibitors have also been found in dormant seeds of woody plants, but there is no good evidence for their modes of action in the seed.

Embryo (or internal) dormancy

- **In another type of embryo dormancy,** called physiological immaturity, a critical enzyme system or other biochemical factor is not in place at shedding and after ripening is required for complete physiological maturation.
- Evidence for the existence of this type of dormancy is weak; probably it is the same as morphological dormancy.

Morphological dormancy.

- Morphological dormancy results from the embryo not being completely morphologically developed when seeds are shed. Additional growth of the embryo is required in an after ripening period.
- Morphological dormancy has been documented in black ash (*Fraxinus nigra* Marsh.) and European ashes, American holly, and several pines that grow at altitudes or latitudes.

Combined dormancy.

- Combined dormancy is a condition in which 2 or more primary factors, such as seedcoat dormancy and embryo dormancy, are present to the extent that each requires treatment to overcome.
- Some examples of combined dormancy in North American species are seeds of Mexican redbud (*Cercis Canadensis var. mexicana* (Rose) Hopkins), skunkbush (*Rhus trilobata* Nutt.), and American basswood.
- For basswood, seedcoat scarification with acid for 10 to 40 minutes, followed by moist stratification for 90 days, is the recommended treatment to overcome dormancy.

Double dormancy

- Double dormancy is a condition in which there is dormancy in both the radicle and the epicotyl of the embryo, but each requires different conditions to overcome the dormancy. This type of dormancy is difficult to demonstrate, but it has been reported for viburnums. A similar condition is found in some oaks, in which radicles are not dormant, but epicotyls are.

Secondary dormancy

- Secondary dormancy results from some action, treatment, or injury to seeds during collection, handling, or sowing. Pine seeds can incur secondary dormancy if exposed to high temperatures and moisture at crucial times. When stratified seeds are redried to storage levels (below 10%), they are often said to have incurred secondary dormancy. Germination can certainly be delayed under these conditions, but this is not a true secondary dormancy.

二、种子催芽

通过机械擦伤、酸蚀、水浸、层积、或其他物理、化学方法，解除种子休眠，促进种子萌发的措施称为种子催芽（**sprouting**）。

种子催芽方法方法很多，常规的有浸种催芽、层积催芽、药剂催芽、机械处理等。

- 层积催芽（stratification）是将种子与湿润物（河沙、泥炭、锯末等）混合或分层放置，在一定温度下，经过一定时间，解除种子休眠，促进种子萌发的一种催芽方法。低温层积催芽是目前种子催芽效果最好的方法之一。低温、变温、混雪三种。
- 低温层积催芽的主要条件是低温、湿润和通气。低温阶段一般控制在0-7℃，待播种前再逐渐升温。湿润物以湿沙、泥炭、蛭石等为宜，湿度为饱和含水量的60%左右 。通气设施可采用秸秆把、竹笼、竹筒等。

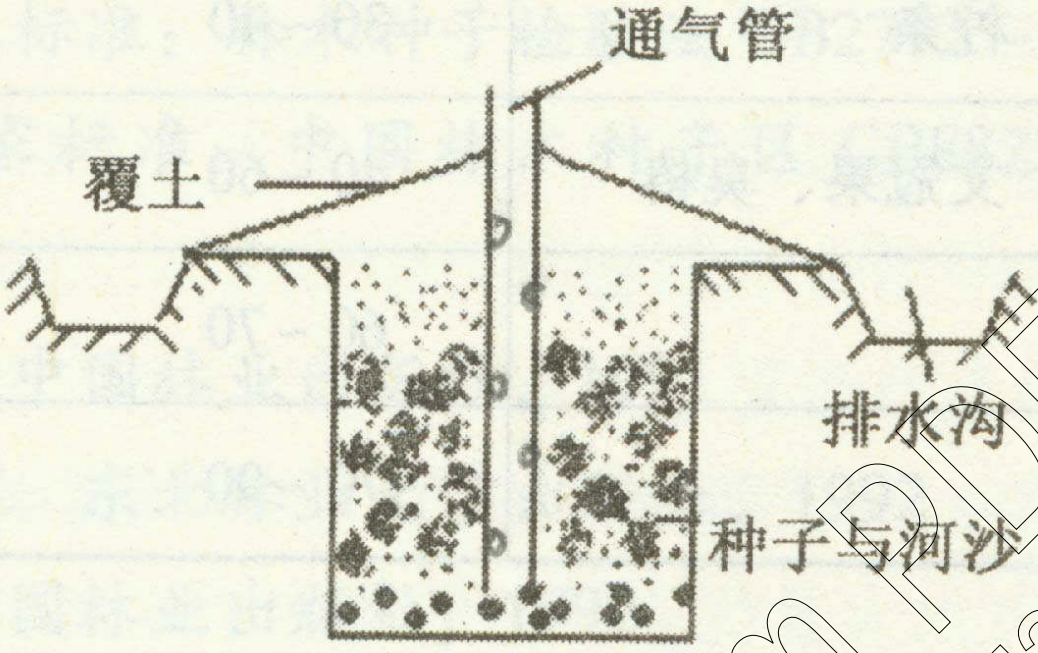
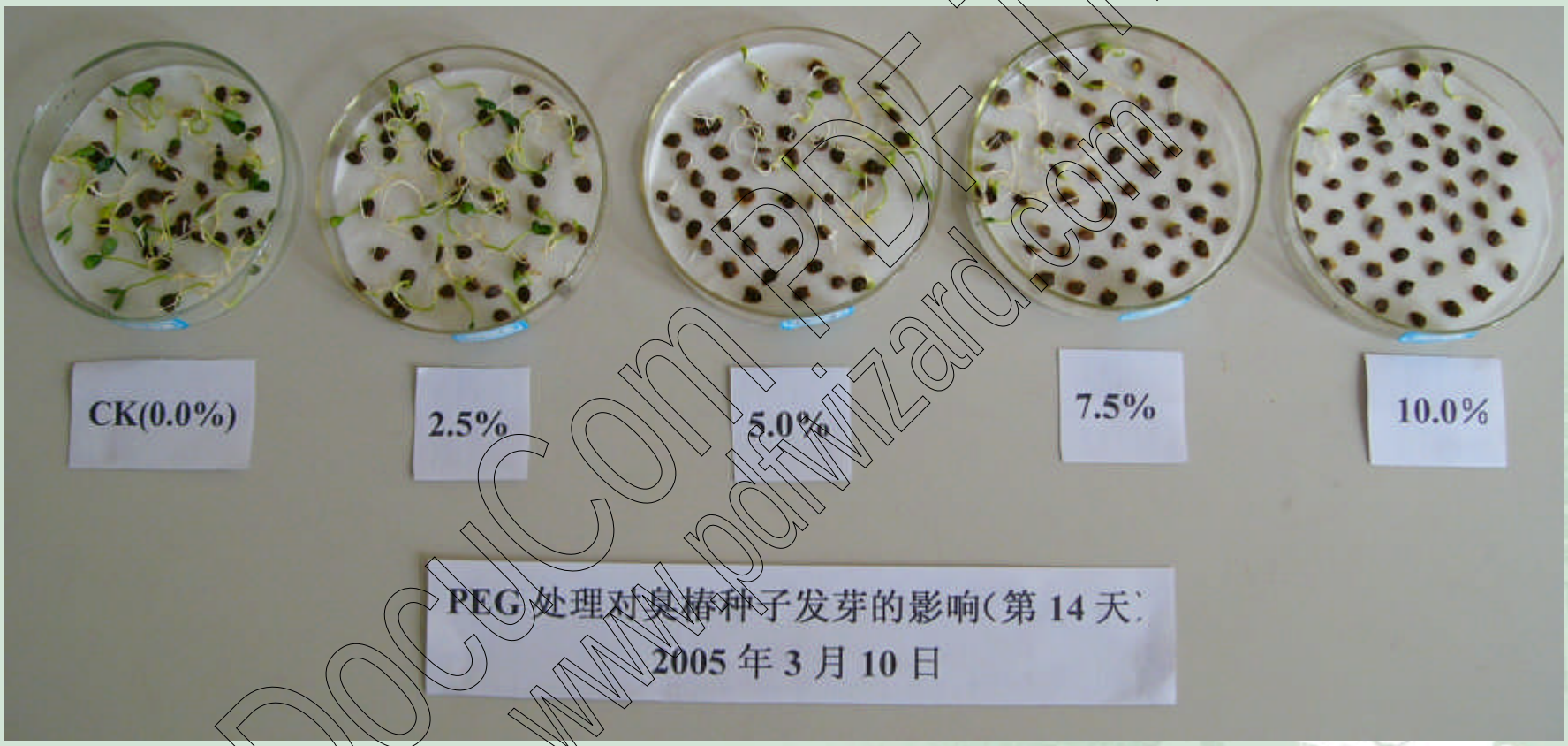


图 2－7　低温层积催芽示意图

- 近年来，种子处理技术有了一些新发展，如：
  - 种子裹衣，在种子为包一层物质。
  - 催芽途径的多样化和综合化。
  - 汽水浸种（**Aerated water soaks**）。
  - 播种芽苗（**Germinant sowing**）。
  - 渗透调节法（**Priming**）。
  - 静电场处理种子。
  - 高锰酸钾液处理。
  - 稀土液处理。

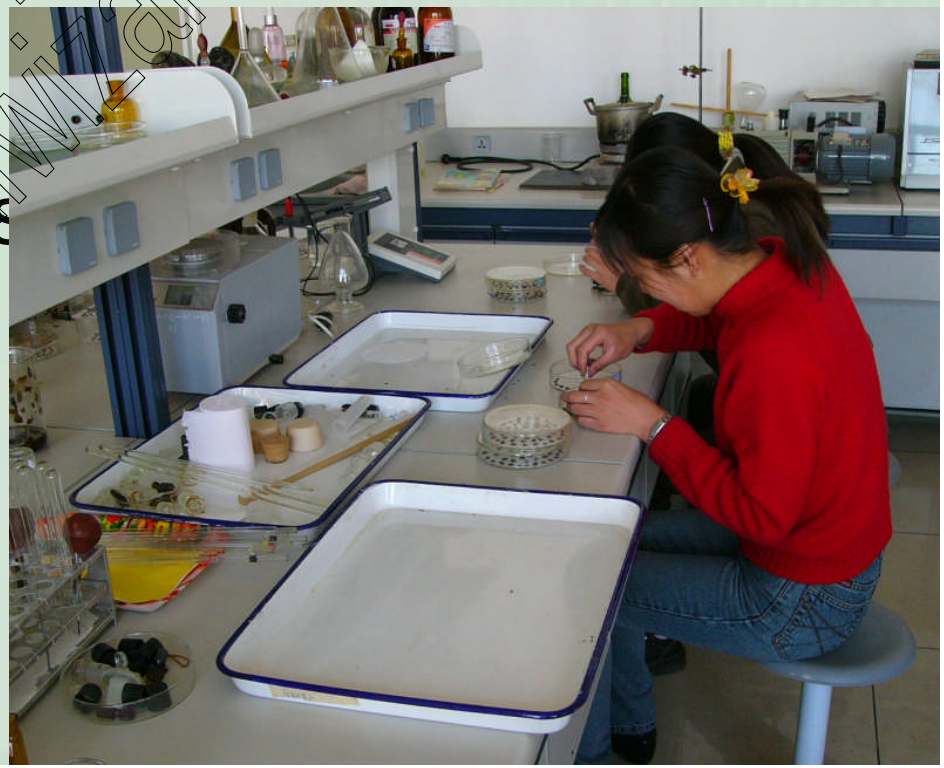


Overcoming Dormancy

- **Seed coat dormancy**
- **Internal dormancy**

Seedcoat dormancy

- Cold water soak
- Hot water soak
- Acid treatment
- Chemical treatments
- Mechanical treatments



Cold water soak

- In some hardseeded species, the seedcoats are not completely impermeable to water. Soaking such seeds in water at room temperature for 24 to 48 hours may be sufficient for full imbibition and subsequent germination.

Hot water soak

- Similar to the cold water soak, except that seeds are put into very hot or boiling water and left there as the water cools. The hot water softens the seedcoats or causes them to crack, and imbibition occurs as the water cools. Numerous leguminous species can be treated in this manner—for example, acacia, albizia, and mesquite.

Hot wire

- This technique requires a heated needle or an electric woodburning tool to burn small holes through seedcoats. A belt-driven burner that scarifies seeds electrically shows promise for treatment of larger lots. “Burned” seeds can be shipped or returned to storage after treatment, something that other scarification methods normally do not allow.

Acid treatment

- Treatment with concentrated sulfuric acid (or other mineral acids such as hydrochloric or nitric acids) is the method of choice for many species. Seeds should be in contact with the acid for 15 to 60 minutes, depending on species or individual seed lot, and washed thoroughly in running water afterward to remove any acid that remains on the seedcoats. Acid has been used in North America to treat honeylocust and Kentucky coffeetree (*Gymnocladus dioicus* (L.) K. Koch), black locust, and snowbrush ceanothus (*Ceanothus velutinus* Dougl.).

Mechanical treatments

- Mechanical scarification is used extensively for large lots of seeds. There are various scarifiers in use, from small cement mixers filled with rough rocks or pieces of broken concrete, to the impact seed gun developed in Denmark. A mechanical device has also been developed to crack peach seedcoats. For small samples, seedcoats can be scarified by hand with knives, files, clippers, sandpaper, etc.

Internal dormancy

- Stratification (prechilling)
- Incubation/stratification
- Chemical treatment
- Combined treatments

Stratification (prechilling)

- The usually procedure for stratification is to refrigerate fully imbibed seeds at 1 to 5℃ for 1 to 6 months. His procedure simulates the natural winter conditions of temperate seeds that are lying on the forest floor. During stratification (1) enzyme systems are activated; (2) stored foods are changed to soluble forms; and (3) the inhibitor/promoter balances change.

Stratification (prechilling)

- One tremendous benefit of stratification for nurseries is an increased uniformity of emergence. The low temperatures used in stratification inhibit germination of seeds that are no longer dormant while the remaining seeds are undergoing the needed internal changes. When the seeds are finally sown in favorable temperatures, there is a flush of uniform germination and emergence, which is crucial to even seedling development. This condition also explains why some non-dormant species appear to respond favorably to short periods (1 to 2 weeks) of stratification with faster and more complete germination.

Incubation/stratification

- A number of species that exhibit complex embryo dormancy or morphological dormancy will germinate quicker if given a warm, moist incubation period to cold stratification. The incubation period promotes embryo growth and other internal processes and is usually shorter than the stratification period. Species for which this treatment has been effective include cherry plum (*Prunus cerasifera* Ehrh.), black ash, and several species of juniper.

Chemical treatment

- Various studies have shown that some species germinate quicker following treatment with exogenous chemical agents. Such as hydrogen peroxide, citric acid, and gibberellins. Although the benefits can be demonstrated in the laboratory with small samples, these agent are rarely, if ever, used in production nurseries.

Combined treatments

- some species—such as American basswood—have seeds with combined dormancy characteristics that seem to require 2 types of treatment for good germination. Impermeable seedcoats must first be scarified before seeds are stratified.