..continued Lect. 2

SEEDS
DORMANCY
What is Dormancy?

• Simply a “block” to the completion of germination to a seed.

• By definition, “a dormant seed is one that does not have the capacity to germinate in a specified period of time under any combination of normal (favourable) physical environmental factors such as temperature, light/dark and moisture” (Baskin and Baskin, 2004)
Basic Concepts in Dormancy

• When a seed matures on a plant, two possibilities will happen, ➔ The seed is able to germinate or the seed will be dormant.
• The freshly dormant mature seed is said to have primary dormancy.
• The freshly mature non-dormant seed after shedding from plant may enter into a dormant state. Now it is called secondary dormancy.
This indicates that a mature seed can enter and leave a dormant state in several cycles before germination commences.

Several weed species are reputed for this.
Classification Systems of Dormancy

• Several classifications of seed dormancy have been proposed, the most well known are

1. Nikolaeva (1969) classified seed dormancy into two categories, *Morphological* and *Physiological*.

2. Nikolaeva (1977) improved the class. system into several sub-categories;
Nikolaeva, 1977 (cont)

I Primary Dormancy

A. Exogenous dormancy. Due to factors outside the embryo.

B. Endogenous dormancy. Due to factors within the embryo itself.
   i. Morphological, and ii. Physiological

C. Combinational
   Morphophysiological & Double Dormancy

II Secondary Dormancy.

Due to imposition of a new dormancy mechanism during unfavourable conditions. e.g. thermodormancy, high temp. will cause seed to dormant.

Simple class. and widely used.
Classification Systems (cont.)


- A. Class - Physiological dormancy (PD)
- B. Class - Morphological dormancy (MD)
- C. Class - Morphophysiological dormancy (MPD)
- D. Class - Physical Dormancy (PY)
- E. Class – Combinational dormancy (PY +PD)
Classification Systems (cont.)

• Classification of seed dormancy very much dependant on the background of a scientist. Classification proposed by Bewley and Black suffice the need of plant physiologists and seed technologists.

• Classification system proposed by Baskin and Baskin no doubt is very comprehensive, however, its seems suitable for Botanists and Plant Ecologists.
Coat-Imposed Dormancy

Dormancy imposed on the embryo by the seed coat or other enclosing tissues such as endosperm, pericarp or other organs.

The embryo of such seeds will germinate in the presence of water and oxygen once the impeding structures are removed.
Mechanisms of Coat-Imposed Dormancy

1. **Prevention of water uptake.**
   Outer covering especially seed coat is the main barrier of water uptake in some species (e.g. some legumes). The presence of waxy cuticles, suberized layers and lignin restrict water imbibition.

2. **Mechanical constraint.**
   Seed coat of some species may be too rigid/hard. Seed coat must be broken by biotic or environmental factors. Certain organs such as endosperm can also suppress expansion of the embryo.
3. **Interference with gas exchange.**

Some seed coats are less permeable to oxygen, thus inhibits germination by limiting the oxygen supply to the embryo. By making a small hole with a pin can improve germination.

4. **Retention/Production of Inhibitors.**

ABA is an inhibitor frequently associated during germination. Some seeds are known to retain inhibitors in seed, render the seeds fail to germinate. In other instances seed coat or pericarps produce inhibitors to block germination process. Soaking seeds in water to leach out inhibitors is an effective method to promote germination.
Mechanisms of Embryo Dormancy

- Three possibilities that may cause embryo dormancy
  1. Embryo is immature morphologically when seed is detached from plant.
  2. The presence of inhibitor(s) in the embryo itself.
  3. Influence of PGH. ABA and GA are frequently implicated with dormancy.
ABA and Embryo Dormancy

• ABA accumulation is developing seed is low during the early stages, is greatest during mid-development (when storage reserves are being synth.) and declines as seed undergoes maturation drying.

A rise in ABA level during embryogenesis triggers the process of desiccation tolerance
• High level of ABA is said to impose dormancy through;

✓ Preventing radicle cell wall loosening,
✓ Interferes with or inhibits GA-induced enzyme production which are responsible for germination
GA and Embryo Dormancy

• GA is not involved in the control of seed dormancy.
• It is important in the promotion and maintenance of germination after the ABA-mediated inhibition of germination is overcome.
• GA plays an important role in the regulation and production of germination-related enzymes especially in cereals.
GA-mediated Germination

GA action in wheat seed germination
In cereals such as rice, corn or barley, upon imbibition GA produced in embryo and than released into the endosperm
GA diffuses into the aleurone layer to produce α-amylase enzyme. GA involves with transcription.
This enzyme is then released into the endosperm to breakdown starch into smaller molecules.
These small molecules are absorbed by scutellum and transported to growing embryo.
Environmental Control of Seed Dormancy

i. Temperature

Control dormancy and control germination rate.

Cardinal temperature characterize germination response to temperature; the minimum ($T_b$), optimum ($T_o$) and maximum temperature ($T_c$)
ii. Fluctuating temperatures
Number of fluctuating cycles within a year break dormancy in the soil. It has ecological advantages for buried seeds.

iii. Light
Break dormancy in many weed seeds in soil. Phytochromes (the photoreceptors) play important role. Prolonged exposure to canopy light inhibits weed seed germ., may be due to low Pfr level.
iv. Nitrate

High nitrate in soil trigger germination in buried seeds. Mechanisms not fully understood. Some species showed different sensitivities at different time of the year.

v. Gaseous environment in soil

Oxygen, CO₂ conc greatly influence weed seed germ. Ethylene is a common in soil atm. and known to release dormancy.

vi. Hormonal herbicides

Modify the dormancy level of surviving seeds
Dormancy Breaking

• Several method to break seed dormancy have been discovered through several years of research by scientists all over the world.
• Some methods proposed may work singly or in combination with several methods.
• Some methods proposed also may work for specific type or class of dormancy, therefore, there is no single universal method can break all dormancy types and all plant species.
Practical Methods

   Tissue removal, puncturing seed coat, high oxygen level, conc. acids.

2. Temperatures.
   Constant 1-10°C are effective in some species. Some species need alternating temperature to break dormancy.

3. Storage after ripening
   Storing mature dry seed at elevated temperature. Seed moisture and temperature will influence the duration of storage.
Storing after-ripening

(seeds were stored at 25°C)
4. Soaking in water

Some inhibitors in seed can be leached out by soaking in water for several hours.

**Location of inhibitors** in seed:
- Embryo, pericarp or testa.

**Type of inhibitors:**
- ABA, short-chain fatty acids, phenolic acids, inorganic ions, coumarin and catechin tannins.
5. **Chemicals**

There are at least 5 classes of chemicals have been discovered and proven to be effective in breaking seed dormancy

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory inhibitors</td>
<td>Cynide, azide, iodoacetate, dinitrophenol.</td>
</tr>
<tr>
<td>Oxidants</td>
<td>Hypochlorite, oxygen</td>
</tr>
<tr>
<td>Nitrogenous cpds.</td>
<td>Nitrate, nitrite, thiourea</td>
</tr>
<tr>
<td>Plant Growth Regulator</td>
<td>GA, Cytokinin, Ethylene</td>
</tr>
<tr>
<td>Various</td>
<td>Ethanol, methylene blue, ethyl ether, fusicoccin</td>
</tr>
</tbody>
</table>
Table 8.3 In species which usually require periods in dry storage, alternative treatments can be used to break dormancy

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>Dry storage period (months)</th>
<th>Alternative treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Triticum aestivum</em></td>
<td>Wheat</td>
<td>3–7</td>
<td>Stratification</td>
</tr>
<tr>
<td><em>Hordeum vulgare</em></td>
<td>Barley</td>
<td>0.5–9</td>
<td>Stratification, GA₃</td>
</tr>
<tr>
<td><em>Avena fatua</em></td>
<td>Wild oats</td>
<td>30</td>
<td>Stratification, GA₃, ethylene</td>
</tr>
<tr>
<td><em>Oenothera odorata</em></td>
<td>Evening primrose</td>
<td>7</td>
<td>KNO₃</td>
</tr>
<tr>
<td><em>Impatiens balsamina</em></td>
<td>Balsam</td>
<td>4–6</td>
<td>Stratification</td>
</tr>
<tr>
<td><em>Rumex crispus</em></td>
<td>Curled dock</td>
<td>60</td>
<td>Light, stratification, alternating</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>temperatures</td>
</tr>
<tr>
<td><em>Lactuca sativa</em></td>
<td>Lettuce cv.</td>
<td>3–9</td>
<td>Light, GA₃, cytokinin</td>
</tr>
<tr>
<td></td>
<td>Grand Rapids</td>
<td></td>
<td>stratification</td>
</tr>
</tbody>
</table>

(Based on Bewley and Black 1994)
VERNALISATION

• The exposure to several weeks of cool temperatures that is required by some plants to initiate bud formation

• $T < T_{\text{optimal}}$

• Vernalization is a stage in the development of many plants, most notably bulbs, fruit trees, and nut trees. This stage involves exposure to cold temperatures for a set period of time, followed by a period of increased photosensitivity which allows the plant to start producing flowers.
• This ensures that reproductive development and seed production occurs at the optimum environmentally favorable time, normally following the passing of winter. The needed cold is often expressed in chill hours.

• Vernalization activates a plant hormone called florigen present in the leaves which induces flowering at the end of the chilling treatment. Some plant species do not flower without vernalization. Many biennial species have a vernalization period, which can vary in period and temperature. Typical vernalization temperatures are between 5 and 10 degrees Celsius (40 and 50 degrees Fahrenheit).
That’s all, Thank You