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Seed Dormancy and Methods of Its Removal

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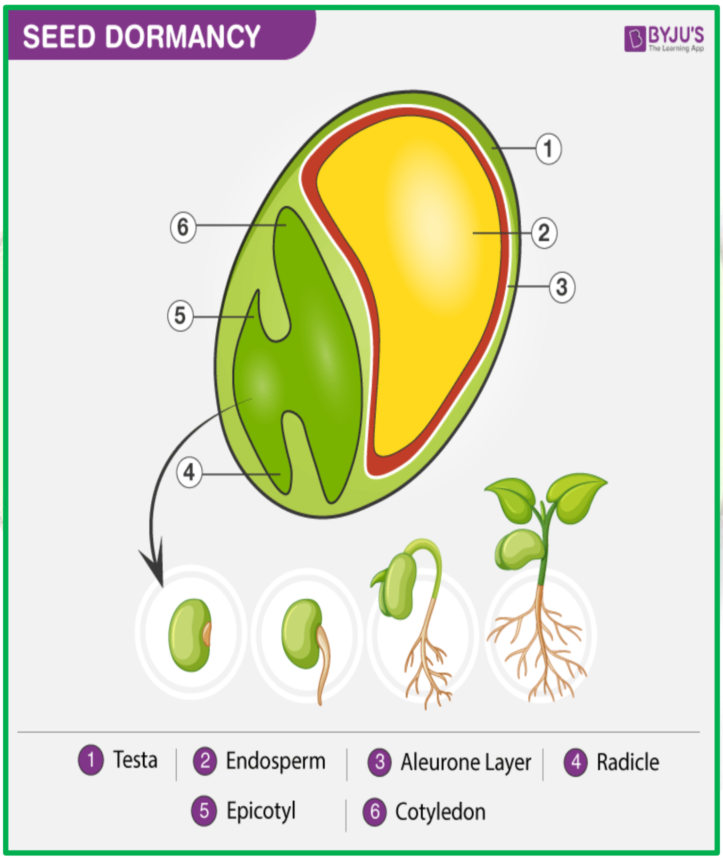
Seed: A seed is a fertilised, ripened ovule of a flowering plant that contains an embryo and is capable of germination to generate a new plant, all of which is coated by a protective coat. A seed (also known as a kernel in some plants) is a little embryonic plant encased in a seed coat, which usually contains some stored nutrients. After fertilisation and some growth within the mother plant, it is the product of the matured ovule of gymnosperm and angiosperm plants. The embryo is formed from the zygote, and the seed coat is formed from the integuments of the ovule, completing the process of reproduction in seed plants (which began with the creation of flowers and pollination).



Dormancy: It is a situation in which seeds do not germinate despite the presence of favourable environment conditions like water, temperature, and air. Some fruit plant seeds (mango, citrus) germinate almost soon after being extracted from the fruit under ideal moisture, temperature, and aeration conditions. However, germination does not occur in several species (apple, pear, cherry) even under ideal conditions.

Seed dormancy is defined as the inability of seeds to germinate under ideal conditions. Immature embryos, seed coat impermeability to water and gases, inhibitors, physiological maturity, light sensitivity, and mechanical restriction by seed coats are all possible causes (Crocker and Barton, 1953; Cresswell and Grime 1981 and Simpson, 1990). According to Come *et al*. (1984), the severity of dormancy is determined by a number of parameters, including the species and variety, the year and location of harvest, and the stage of seed development.

Types of Dormancy

Different types of seed dormancy include following:

1. Exogenous Dormancy

Factors outside the embryo impose this sort of dormancy. The tissues surrounding the embryo can influence germination by inhibiting water uptake, providing mechanical resistance to embryo expansion and radicle emergence, modifying gaseous exchange (limiting oxygen to the embryo), preventing inhibitor leaching from the embryo, and supplying inhibitor to the embryo in exogenous dormancy.

2. **Endogenous dormancy:** At the time of ripening or maturity, a rudimentary or underdeveloped embryo imposes this kind of dormancy. There are several varieties of dormancy, including morphological, physiological, double dormancy, and secondary dormancy.

Advantages

1. Allowing germination only when environmental conditions are favourable for seedling survival, as in temperate fruit plants.
2. Aided in the establishment of a "seed bank"
3. Dormancy can also be used to time the germination of seeds to a specific season.
4. Specialized dormancy conditions can help with seed disposal. For example- modification of the seed covering by digestive tract of a bird or other animals.

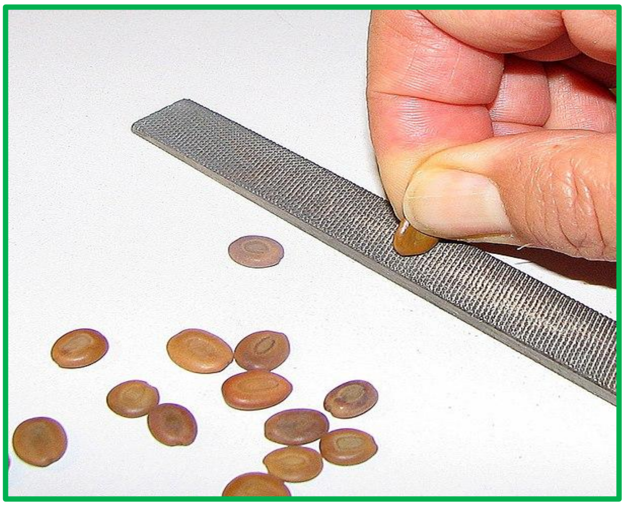
Disadvantages

1. Overcoming dormancy necessitates a long amount of time (for uniform germination)
2. Aids in the lifespan of weed seed.
3. Maintaining the population in the field while growing a crop is extremely tough with a dormant seed lot.

Methods of Removal:

Seed dormancy in horticultural crops is broken using a variety of approaches. Here's a quick rundown of what they're all about:

1. Softening seed coat and other seed coverings: This aids in better absorption of water as well as gases, which in turn results in better germination of the seeds. This can be obtained by scarification.



a) Scarification: It is the process of breaking, scratching, mechanically altering/softening the seed covering in order to make it permeable to water and gases. There are three types of treatments which are commonly used as scarification treatments. These treatments include mechanical, chemical and hot water treatments.

i) Mechanical scarification

- It is a simple and effective method if suitable equipments are available.
- Crushing hard seed coats with sand paper, cutting with a file, or cracking with a hammer are basic ways good for modest amounts of reasonably large seeds.
- Mechanical scarifiers are employed on a large scale. Seeds can be crushed in sand paper-lined drums or concrete mixers with coarse sand or gravel. To make future separation easier, the sand gravel should be a different size than the seed.
- Scarification should not be carried out to the point where the seeds are harmed or the seed's inner components are revealed.

ii) Acid scarification

Dry seeds are placed in containers and coated with concentrated Sulphuric acid (H_2SO_4) or HCl in a one-to-two ratio of acid to seed. Naredo et al. (1998) discovered that a combination of seed hull, dry heat or chemical treatment, and germination at optimal temperatures was efficient in breaking seed dormancy.

- To avoid uncontrollable heating, the amount of seed treated at any given time should be limited to no more than 10kg. Containers should be made of glass, earthenware, or wood, and should not be made of metal or plastic. The mixture should be mixed carefully at intervals during the treatment to obtain uniform outcomes.
- The period may vary from 10 minutes to 6 hours depending on the species.
- When dealing with thick-coated seeds that need to be scarified over a long period of time, the scarification process can be assessed by taking samples at regular intervals and measuring the thickness of the seed coat. The treatment should be stopped as soon as it becomes paper thin.
- The acid is drained off at the conclusion of the treatment period, and the seeds are washed to eliminate the acid.
- The acid-treated seeds can be planted right away if they are still wet, or they can be dried and stored for later planting. Sulphuric acid treatment has been reported to work on large seeds of most legume species, brinjal, and tomatoes.

iii) Hot water scarification

- Soak the seeds in 4-5 times their amount of boiling water, ranging from 77 to 100 degrees Celsius.
- Remove the heat source immediately, and soak the seeds for 12 to 24 hours in the continuously cooking water. After that, suitable screens can be used to separate the unswollen seeds from the swollen seeds.
- The seed should be sown as soon as possible after being treated with hot water.

iv) Warm moist scarification

- The seeds are placed in a wet warm medium for several months to allow microbial activity to weaken the seed coat and other seed coverings. Seeds with double seed dormancy benefit greatly from this treatment.
- Stone fruit (cherry, plum, apricot, and peaches, for example) exhibit improved germination if planted early enough in the summer or fall to provide one to two months of warm temperature before the onset of cold.

b. Stratification

- Stratification is a method of treating dormant seeds that involves chilling the embryo after it has ripened in alternate layers of sand or soil for a predetermined amount of time. It's sometimes referred to as moist chilling.
- However, temperate species with epicotyl dormancy (such as fringed trees) or an underdeveloped embryo (such as hollies) require a warm stratification preceded by a moist cold stratification.
- Several tropical and subtropical species (such as palms) necessitate a period of warm stratification prior to germination in order for the embryo to continue developing after the fruit has dropped.
- After the fruit has dropped, the seeds can be planted. After stratification in the field, the seeds can be sown right away. Prunus seeds, for example, have a firm endocarp.
- If refrigerated storage facilities are not available, seeds with a hard endocarp, such as Prunus spp. (the stone fruit including cherry, plum, apricot, and peaches), show increased germination if planted early in the summer or fall to provide one to two months of warm temperature prior to the onset of chilling.

i) Outdoor stratification:

- If refrigerated storage facilities are not available, outdoor stratification can be done by storing seeds in open field conditions in deep pits or in Excessive rains, freezing, drying, or rats are all likely to harm seeds in the outdoors.
- Seeds are placed in alternate layers of sand in the stratification pit to maintain a low temperature and appropriate aeration. To keep the moisture level up, the top is covered in Sphagnum moss.
- The pit or tray is watered at regular intervals to maintain optimum moisture status.

ii) **Refrigerated stratification:**

- An alternative to outdoor field stratification is refrigerated stratification.
- It is useful for small seed lots or valuable seeds that require special handling.
- Dry seeds should be fully imbibed with water prior to refrigerated stratification. Twelve to twenty four hours of soaking at warm temperature may be sufficient for seeds without hard seed coats.
- After soaking, seeds are usually placed in a convenient size box in alternate layers of well washed sand, peat moss or vermiculite
- A good medium is a mixture of one part of coarse sand to one part of peat, moistened and allowed to stand for 24 hours before use. Seeds are placed in alternate layers of sand or medium.
- The usual stratification temperature is 4-7^{0}C. At higher temperature seeds sprout prematurily and at low temperature, sprouting is delayed.
- The medium should be moistened again. Prior to sowing in nursery beds, the stratified seed is separated from the medium.
- Seed stratification results in speedy and uniform germination, hence the seed should be stratified invariably under all conditions.

iii) Leaching of inhibitors:

It is well recognised that many species' seed coverings include inhibitors and phenolic chemicals that prevent germination. As a result, soaking seeds in running water for 12-24 hours or submerging them in water for a few hours aids in the removal of inhibitors and phenolic chemicals, allowing for easier seed germination.

iv) Pre-chilling:

Prechilling treatment can be used to break dormancy in seeds of certain plant species. The imbibed or soaked seeds are stored at a temperature of 5-10 ^{0}C for 5-7 days before sowing in this procedure. Seed can then be sown in the field right away.

v) Pre-drying:

This is also a good way to get rid of seed dormancy in some seeds. The dry seeds are exposed to a temperature of 37-40 ^{0}C for 5-7 days prior to sowing in this procedure. Seed can then be planted on the field. Pre-drying at 50°C for five days followed by soaking in tap water for 24 hours was determined to be the most efficient way of breaking dormancy in IR 64 (variety of rice) by Nugraha and Soejadi (1991).

vi) Seed priming:

Seed priming is a term used to describe the processes used to break the dormancy of newly harvested fruits. Osmo-conditioning, infusion, and fluid drilling are the most common seed priming methods.

vii) Treatment with chemicals:

Other substances, including hormones, are utilised to overcome dormancy, although their function is unknown. Thiourea is one example of a substance that has been shown to help dormant seeds germinate. For 3-5 minutes, the seeds are immersed in a 0.5–3% thiourea solution. After that, the seeds are rinsed and planted in the field. Potassium nitrate and sodium hypochlorite, on the other hand, enhance seed germination in a variety of plant species. Sikder (1967) discovered that treating rice seeds with N/10 H_2SO_4 for 4 hours increased germination by increasing the glume permeability to oxygen.

viii) Hormonal treatment:

GA_3 is a hormone that is used commercially to break seed dormancy in many types of seeds. The concentration of GA_3 varies depending on the type of seed, although a range of 200-500 ppm is commonly utilised.

• Cytokinin is a hormone family that is utilised to break physiological dormancy and stimulate seed germination in a variety of species. Kinetin and BA (6-benzyle aminopurine) are commercially available cytokinin formulations that are used to break seed dormancy. For many species, soaking seeds in a 100 ppm kinetin solution for 3-5 minutes is a highly effective concentration for breaking seed dormancy. Etheral also promotes seed germination in several species.

Role of Hormones in Seed Dormancy

Plant hormones affect distinct components of the seed to affect germination and dormancy. The seed has a high ABA sensitivity and a low GA sensitivity, but embryo dormancy is characterised by a high ABA/GA ratio. GA3 had the ability to considerably increase the germination of dormant grain seedlings, according to Lang (1965). To break the seed's dormancy and allow it to germinate, it must undergo changes in hormone biosynthesis and degradation that result in a low ABA/GA ratio, as well as a decrease in ABA sensitivity and an increase in GA sensitivity.

- Plant regulators can be employed to either break or extend dormancy. In storage, sprouting of potato tubers and onion bulbs is a regular occurrence.

- To inhibit spouting, a pre-harvest spray of maleic hydrazide (MH) at 2000 ppm administered 15 days before the actual day of harvest prolongs dormancy in the above storage organs.
- Spraying Dinitro orthocresol at 0.1 percent in oil emulsion on apple, plum, and fig trees causes early flowering.
- A seed treatment of 100 ppm GA breaks the dormancy of tomato seeds and enhances the percentage of germination.
- GA breaks the dormancy by enhancing embryo growth potential and/or weakening the seed coat, allowing the seedling's radical to break through. Seed coats can be made up of living or dead cells, and both can be impacted by hormones; seed coats made up of living cells are acted upon after seed production, whereas seed coats made up of dead cells can be influenced by hormones during seed coat formation.
- ABA influences the GA-mediated embryo growth potential by affecting testa or seed coat growth parameters, such as thickness. These circumstances and consequences occur during the seed's formation, and are frequently influenced by external factors. Hormones are also involved in the dormancy of endosperm.
- In most seeds, the endosperm is made up of live tissue that can respond to hormones produced by the embryo. The endosperm has a role in barrier to seed germination, playing a role in seed coat dormancy or in the germination process.

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