Lecture :8

SEED DORMANCY

It is the phenomenon of failure of a viable seed to germinate even under favourable environmental condition such as light, temperature, aeration etc.

Significance of Dormancy

1. From an ecological perspective, dormancy is an important survival mechanism that favours propagation and dissemination of seeds to establish plant populations.
2. Dormancy allows the seeds to remain in suspended animation without any harm during drought, cold or high summer temperature.
3. The dormant seeds can remain alive in the soil for several years. They provide a continuous source of new plants even when all the mature plants of the area have died down due to landslides, earth quake, floods, epidemics or continued drought.
4. It helps the seed to get dispersed over long distances through unfavourable environment or inhospitable area.
5. The small seeds with impermeable seed coat belonging to edible fruits come out of the alimentary canals of birds and other animals uninjured e.g., Guava.
6. Dormancy induced by the inhibitors present in the seed coats is highly useful to desert plants. The seeds germinate only after a good rainfall which dissolves away the inhibitors. The rainfall ensures the seed a proper supply of water during its germination.
7. It follows storage of seeds for later use by animals and man.

Dormancy Classification

Basically it is of two types-

A) Primary dormancy: It induced during seed development resulting in seeds that are dormant when dispersed from the mother plant.

B) Secondary dormancy: It induced by unfavourable environmental conditions following shedding of mature seeds from the parent plant. Secondary dormancy can be induced by conditions unfavourable for germination, such as adverse temperatures, illumination or oxygen. Types of secondary dormancy include:

i) Thermodormancy: It is caused by prolonged exposure of imbibed seeds to temperatures unfavourable for germination, generally high temperatures.

ii) Skotodormancy: It is induced in seeds that require light for germination when they are imbibed in the dark for extended periods of time.

iii) **Photodormancy:** It occurs in seeds that are inhibited by light when they are exposed to an excess of light.

Note, that secondary dormancy is not only induced in non-dormant seeds, but also in seeds that already have some form of primary dormancy. For example, a lettuce seed that requires light to germinate is said to be photosensitive and, when imbibed in the dark, it will not germinate until light is provided. However, if dark imbibition is extended for a period of time, skotodormancy can be induced and the seed will not germinate even if it is placed under optimum light conditions.

However, primary dormancy can again be classified into the following ways-

A. Seed coat dormancy

1. Physical dormancy – Here the seed coats are impermeable to water and gases. Crops of Leguminaceae, convolvulaceae, malvaceae, chinopodiaceae and solanaceae has this type of dormancy. Here the embryo is generally quiescent (non-doamant). The cause of physical dormancy is the structure of the outer cell layer which becomes impermeable to water gasesand . Macrosclereid cells, a mucilaginous outer cell layer, or a hardened endocarp are three reasons that seed coats become impermeable to water and gases. Such seed coats develop during the last stages of seed development.

2. Mechanical dormancy - Seed coats are too hard to allow the embryo to expand during germination. Causes include: Structure of seed coats or remaining fruit. Occurs in walnut, pecan nut etc.

3. Chemical dormancy - Presence of chemical inhibitors (phenols, ABA, caumarin) in the outer coverings of many fruits and seeds. This occurs in fleshy fruits, hulls, and capsules of many dry fruits. Examples are apples, citrus, grapes, desert plants. Very often this kind of dormancy disappears with dry storage. This kind of dormancy may also be present in other tissues surrounding the embryo such as the endosperm.

B. Morphological dormancy- Embryo is not fully developed at time of ripening and they remain in rudimentary condition. Hence, they need additional embryo growth after the seed is separated from the plant. This type of dormancy mainly observed in several herbaceous flower, seed such as Ranunculus, poppy; temperate zone species such as holly, snowberry; tropical plants such as date palms.

C. Endogenous dormancy: Here the dormancy is controlled internally within the living tissues of the seed. It may be of two types-

i. **Physiological dormancy:** Most of the temperate fruits (apple, pear, peach, plum, cherry), vegetables and flowering annuals have physiological seed dormancy lasting from 1-6 months, which disappear on storage. The seeds of these species have physiologically immature embryo and they do not germinate even under favourable conditions.

ii. **Embryo dormancy:** Here the dormancy is due to dormancy of the embryo which over winter in soil and germinate in spring under natural condition.

D. Epicotyl dormancy: Seeds of some species have different stratification requirement for the growth of their radicles, hypocotyls and epicotyls and this type of dormancy is called as epicotyls dormancy. On the basis of chilling requirement for epicotyls, different plant species are divided into two sub groups. In one group, seed germinate initially during warm period of 1-3 months and produce roots and hypocotyls but these require 1-3 months chilling for epicotyls to germinate as in lily and peony. In second group, it requires a certain amount of chilling period to after ripen the embryo followed by a warm period for the roots to grow and again a chilling period to stimulate shoot growth as in Trillium.

E. Double dormancy: In certain plant species, seeds have dormancy due to hard seed coats and dormant embryos. This is called as double dormancy. For proper germination, both the blocking conditions must be modified to allow water to penetrate the embryo and after ripening of the embryos. This type of dormancy is found in trees and shrubs producing seeds with hard seed coats, grown primarily in cold winter area. To overcome the problem of double dormancy, the seeds are first treated in a way to soften the seed coat and then cold stratification treatment is given to them.

Methods to Overcome Dormancy

The methods to overcome dormancy are better understood once the mechanisms of dormancy are known. For instance, if the cause of dormancy is an impermeable seed coat that impedes seed water uptake, removing the seed coat or reducing its permeability should break dormancy. When dormancy is caused by an underdeveloped embryo, additional time for embryo growth should overcome dormancy. Finally, when dormancy is imposed by a physiological mechanism, actions that decrease the amount of or sensitivity to dormancy-inducing compounds (e.g., ABA), along with actions that increase the amount of or sensitivity to dormancy-breaking compounds (e.g., GA) should break dormancy. The effective methods to overcome seed dormancy are as follows-

1. Softening seed coat and other seed coverings: This helps in better absorption of water and gases, which ultimately leads to better germination of the seeds. This can be achieved by the

process called scarification. It is the process of breaking, scratching, mechanically altering or softening the seed covering to make it permeable to water and gases. Different forms of scarification are as follows-

i) Mechanical scarification: It is simple and effective means of scarification. It involves the scratching or injuring the hard seed coat by rubbing with sand paper or against any rough surface.

ii) Acid scarification: It involves the treatment of dry seeds with concentrated Sulphuric acid (H_2SO_4) or HCl in the ratio of one part of seed to two parts of acid. The amount of seed treated at any time should be restricted to not more than 10 kg to avoid uncontrollable heating. The containers should be of glass, earthenware or wood, non- metal or plastic. The mixture should be stirred cautiously at intervals during the treatment to produce uniform results. The time may vary from 15 minutes to 6 hours depending upon the species. With thick-coated seeds that require long periods, the process of scarification may be judged by drawing out samples at intervals and checking the thickness of the seed coat. When it becomes paper thin, the treatment should be terminated immediately. At the end of the treatment period, the acid is poured off and the seeds are washed with running tap water for 10-15 min to remove the acid. The treated seeds may place in large amount of water with small amount of baking soda to neutralize the adhering acid. Thereafter, the treated seeds can either be planted immediately when wet or dried and stored for later planting.

iii) Hot water scarification: Drop the seeds into 4-5 times their volume of hot water with temperature ranging from 77 to 100^{o}C. The heat source is immediately removed, and the seeds soaked in the gradually cooking water for 12 to 24 hours. Following this the unswollen seeds may be separated from the swollen seeds by suitable screens. The seed should be sown immediately after hot water treatment.

iv) Warm moist scarification: The seeds are placed in moist warm medium for many months to soften the seed coat and other seed coverings through microbial activity. This treatment is highly beneficial in seeds having double seed dormancy. The hard seeds are planted in summer or early fall when the soil temperature is still higher, that usually facilitates germination. For instance the stone fruit including cherry, plum, apricot, peaches etc show increased germination if planted early enough in the summer or fall to provide one to two months of warm temperature prior to the onset of chilling.

v) Harvesting immature fruits: In certain plant, seeds are extracted pre-maturely to avoid the development of hard seed coats. Such seeds should be sown immediately after extraction.

2. Stratification: It is a method of handling dormant seed in which the imbibed seeds are subjected to a period of chilling to after ripen the embryo in alternate layers of sand or soil for a specific period. It is also known as moist chilling. It can be achieved by the following methods-

i) Refrigerated stratification: In this practice, dry seeds are 1st soaked in warm water for 12-24 hrs. After soaking, seeds are usually placed in a convenient size box in alternate layers of previously prepared medium containing well washed sand, peat moss or vermiculite. The boxes are placed in the refrigerator at a temperature of 4-7^{o}C. At higher temperature seeds sprout prematurity and low temperature delays sprouting. The time for keeping the seed in refrigerator depends on the kind of seed. Usually it takes 1-4 months time. However, during the process care should be taken to examine the boxes periodically and if the seeds are dry, the medium should be re-moistened immediately.

ii) Outdoor stratification: If refrigerated storage facilities are not available, outdoor stratification may be done either by storing seeds in open field conditions in deep pits or in raised beds enclosed on wooden frames. However it is likely that seeds are destroyed in outdoors by excessive rains, freezing, drying, or by rodents. Seeds are placed in alternate layers of sand to provide and low temperature and proper aeration in the stratification pit. The top is covered with Sphagnum moss to maintain moisture level. The pit or tray is irrigated at regular intervals to maintain appropriate moisture status.

iii) Outdoor planting: Seeds of different species require cold treatment for after ripening of the embryos. Such seeds may be planted directly in the seedbeds, when the natural environmental conditions are favourable for them. The seeds should be sown in such a way that they may get proper moisture and make use of all other natural conditions, particularly the winter chilling period. The seeds, in general germinate quickly during spring when the soil temperature begin to raise.

3. Leaching of inhibitors: It is established fact that some inhibitors and phenolic compounds are present in seed coverings of many species, which inhibit germination. Therefore, soaking of seeds in the running water for 12-24 hours or placing them in water for few hours help in leaching off the inhibitors and phenolic compounds, which help in easy germination.

4. Pre-chilling: In seeds of certain plant species, dormancy can be overcome by pre-chilling treatment. In this treatment, the imbibed or soaked seeds are kept at a temperature of 5-10^{0}C for

5-7 days before sowing. After that seed can be sown in the field immediately.

5. Pre-drying: This is also a useful practice in some seeds to overcome seed dormancy. In this treatment, the dry seeds are subjected to a temperature of 37-40^{0}C for 5-7 days prior to sowing. After this, seed can be sown in the field.

6. Hormonal treatment: GA (200-500 ppm) is commercially used to break dormancy. However, soaking of seeds with kinetin (cytokinin) @ 100 ppm solution for 3-5 min is also effective to overcome dormancy in many seeds.

7. Seed priming: Seed priming refers to the procedures followed to overcome dormancy in freshly harvested fruits. Most widely used seed priming procedures are osmo- conditioning, infusion and fluid drilling.

- In osmo-conditioning, the seeds are placed in shallow layer in a container having 20-30 per cent solution of polyethylene glycol (PEG). The seeds are then incubated at 15-20^{0}C for 7-21 days, depending upon seed size and plant species. Different hormones and fungicides can also be added in PEG solution to protect the seeds from pathogens. After it, the seeds are washed and dried at 25°C and are stored until use.
- In infusion, the hormones, fungicides or insecticides and antidotes are infused into dormant seeds through organic solutions. In this process the seeds are placed in acetone or dichloromethane solution containing chemicals to be used for 1-4 hours. Afterwards, the solvent is allowed to evaporate and seeds are dried slowly in vacuum desiccators for 1-2 hours. The seeds absorb the infused chemical directly into the embryo when soaked in water.
- In fluid drilling, the seeds are suspended in a special type of gel before sowing. Now-a-days different types of gels are available in the market but sodium alginate, guar gum and synthetic clay are most widely used in fluid drilling.

8. Treatment with chemicals: Some compounds other than hormones are also used to break dormancy but their role is not clear. Thiourea is one example known to stimulate germination in some kinds of dormant seeds. The seeds are soaked in 0.5 – 3 per cent solution of thiourea for 3- 5 minutes. Afterwords seeds are rinsed with water and are sown in the field. Similarly, potassium nitrate (0.1-2%), hydrogen peroxide (5%) and sodium hypochlorite also stimulate seed germination in many plant species.