Seed Dormancy: Germination, Definition, and Mechanism

Seed Dormancy

Optimal conditions support the seed germination under prerequisite condition; hydration of seed marks germination of the plant.

The absence or minimal expression of prerequisite conditions will make the seed to enter a stage of inactivity – quiescence stage.

The metabolic conditions are pertained in this state but the differentiation and development are inhibited. The state is termed as Dormant stage.

Dormancy is a stage of inactivity induced in developing plant parts when subjected to stress such as insufficient water imbibition, low temperature, oxygen or other factors; establishing an undesirable effect on plant germination simultaneously increasing the survival capacity of the plant by temporary impairment in development of plants.

Seed dormancy is an inherited phenomenon acquired during the course of evolution in almost all species of plants.

The phenomenon remains untraceable through the evolutionary history of plants. But a major understanding is that, plants in equatorial region show reduced or no dormancy.

As we move away from the equator the plants increase the tendency of dormancy. Though many factors are involved in determining the dormancy a true working mechanism of dormancy yet remains unclear.

Understanding seed dormancy prevailed from 372 BC, Greek philosopher Theophrastus known as the Father of Seed Physiology has studied seed dormancy.

Recent studies on seed dormancy are minimal and the mechanism and factors involved are not discovered authentically.

Characteristic Features of Seed Dormancy

1. An acquired inherited feature: The process is an age-old characteristic feature of plants which are subjected to constantly varying environment is acquired and passed on from generation to generation.

2. Inactivation is temporary: The dormant seed remains the same till a favorable condition develops to support the germination.

3. Defense mechanism: The seed is protected and preserved without exposing the seedling to harsh climatic condition. With a suitable environmental stimulus, the seed becomes competent to develop

4. Generally, dormancy can be seen as adaptation to survive under extreme stress, which a plant acquired during evolution

5. Evolutionary outcome: Prevalent over wide range of plant species and prominent in plants which are far away from the equator. This phenomenon is seen as an adaptation pertaining to evolution to ensure the development and differentiation of different species of plants.

6. A resting state: This state of inactivation is just a wait for a favorable condition and the seed does not lose its capacity and maintains a minimal metabolic activity as that takes place in non – dormant seeds.

Types of Seed Dormancy

Generally, Dormancy can be classified based on the type of inhibition;

1. Eco Seed Dormancy: The inhibition to growth is provided by the absence or minimal exposure of any external factors.

For Example: under cold temperature the mature onion bulbs enter a resting state.

2. Para Seed Dormancy: The growth is inhibited by other parts of the same plant.

For Example: Apical dominance of the apical bud to suppress the lateral bud development.

3. Endo Seed Dormancy: The inhibition is present in the plant part. The seed or bud or the tuber even on optimal condition fails to germinate.

The dormancy is caused by For Example: Seed coat becomes unbreakable or the embryo is efficient to the proper stimuli.

Endo dormancy further divided as Developmental Endo dormancy or Seasonal Endo Dormancy; where the dormancy is caused by the immaturity

of the embryo and by intrinsic response to the climatic condition of the environment respectively.

Seed dormancy can be imposed in stages: Primary and Secondary

a. Primary Seed Dormancy: Dormancy expressed by a mature, newly dispersed seed due to endogenous inhibition like Hard coat induced dormancy or Immature embryo dormancy. The seed remains dormant even under favorable condition

b. Secondary Seed Dormancy: Dormancy is forced due to unfavorable exposure of environmental condition after seed germinates inhibiting its development.

a. Primary Seed Dormancy

(i) Coat Related Seed Dormacy

Coat related seed dormacy or Coat enhanced dormancy arises due to hard seed coat. This type is prevalent in families Fabaceae and Malvaceae.

Hard seed coat imposes various physiological and mechanical restraints for a seed to germinate. Hard seed coat is a defensive function to protect the embryo of many plants.

It also constitutes to wear and tear during dispersal mechanism. The defense functions are species specific.

Different species develops different seed coat to protect them from the harsh conditions.

For example: Xanthium – seeds are impermeable for gases, certain seeds are coated with waxes to prevent water imbibition, Conifers develops megagametophyte which prevent entry of water.

Mesquite – has lignified Testa, if a seed coat lacks Testa the endospermal wall becomes rich in hemicellulose. These are certain plants with different mechanism to protect the seed.

Such hard protecting coat can be impenetrable for the radicle causing a constraint to germinate.

Such hard coat will prevent water imbibition, gaseous exchange, retains the inhibitory components such as ABA (abscisic acid).

Identifying the reason behind dormancy will help to break the dormancy in vitro. But naturally the seeds have natural dormancy breakers in the environment.

It also depends upon the dispersal mechanism. Certain seed may require animal gut digesting enzymes to break open the seed coat.

Other seeds have cellular enzymes present in the soil aids in seed coat opening. Microorganisms in soil or in any medium where the seed develops are responsible for coat disintegration.

Inhibitions can be classified as;

1. Mechanical restraint

2. Gaseous exchange intervention

3. Retention of inhibitors

1. Mechanical restraint

Seeds with hard seed coat impose a mechanical constraint for the radicle to develop. This is broken by cellular digesting enzymes present in the soil.

For Example: Coffee seeds.

2. Gaseous exchange intervention

Phenolic compounds present in certain seeds take up high amount of oxygen content. The developing embryo receive low oxygen because of the phenolic compounds requires a high amount of oxygen to develop into plant.

Exposing such seeds to high oxygen environment will induce germination.

3. Retention of inhibitors

To prevent pre mature development of radicle, ABA is present in the seed coat inhibiting germination. These inhibitors are secondary metabolites.

Apart from ABA, Phenolic Acid, Coumarin and tannins are also additional inhibitors present at different species. these inhibitors prohibit germination.

Overcoming such condition through continuous rinsing of seeds in water will induce germination, provided optimal growth factors.

Seed Dormancy due to hard seed coat can be germinated by removing seed coat mechanically or chemically. A method which is employed under a favorable condition to remove the seed coat and induce germination is called as Scarification.

Mechanically, the coat can be removed by scratching it with knife or shaking against a coarse surface.

Chemically, a strong acid (i.e.) Sulphuric acid or organic solvent such as alcohol or acetone can be used to remove the seed coat inhibiting growth.

In few cases even boiling the seed in water eliminates the seed coat and initiate germination.

(ii) Immature Embryo Related Seed Dormacy

When a seed dehisces from the plant, there are two cases in which a seed might be present.

Case 1: the seed is matured and then released.

Case 2: Seed is still immature during dispersal.

Seeds with immature embryo belongs to Fraxinus and Anemone comes under case 2. Immaturity causes dormancy in seeds.

Under unfavourable condition they seeds might decay. the seeds reach maturation by a process of stratification. the maturation is termed as after – ripening.

Stratification takes place during autumn where the seeds are stored in layers of autumn soil, debris and snow. the cold and moisture will mature the seeds and allow them to germinate.

Artificially, the seeds are kept in the layers of sand and sphagnum which will provide them necessary conditions to germinate.

The process of after – ripening is species specific and along with stratification the seeds mature. Dormancy in certain other plants is broken by dry storage.

By the hormone balance theory, the seed has a network of hormones regulating germination.

Abscisic Acid, Gibberellins, Brassanosteroids and Ethylene form an integrated network in regulating the germination and dormancy.

Dormancy of the seed is promoted by ABA. ABA is produced from the maternal tissue to regulate the dormancy by preventing precocious germination.

For a seed to germinate the ratio of GA and ABA must be maitained.GA must be higher than ABA to over throw the inhibitory effects of ABA.

ABA also inhibits ethylene but presence of Brassanosteroids promotes ethylene which is essential for germination.

a. Secondary Seed Dormancy

Secondary dormancy is prevalent when the seed is physiologically fit and environmental factors governing the germination are absent causing a stress in seed.

Factors Causing Secondary Seed Dormancy

1. Light: Light is not an essential source supporting the germination, as the process takes place underground. But absence of light in certain Lettuce causes dormancy in seeds.

These are Positive Photoblastic seeds where the presence of light induces germination. Positive Photoblastic seeds require 660 mμ provided by red light.

Far red light at 735mμ inhibits the germination. Photo regulation is governed by pigment phytochrome which absorbs the light and detects the changes.

Similarly, germination of certain seeds takes place in dark environment and are called as negative photoblastic seeds.

2. Water: Water imbibition in seeds is a prerequisite for germination. Seeds which lack imbibition fails to germinate.

3. High CO2: High CO2 inhibits the germination as O2 is essential for regular metabolic activities of the seeds, excess CO2 inhibits the uptake of O2 causing dormancy.

4. Temperature: Temperature requirement varies for each plant. Certain plants require higher temperature for germination and others require moderate temperature.

Plants are also sensitized for low temperature treatment as in stratification before they are sown in land. Unavailability of such factors induce a secondary dormancy in mature embryo bearing seeds.