PHYSIOLOGY OF DORMANCY

During the developmental cycle of the plant, at some phase or the other certain structures like buds, tubers, seeds, etc., go through a period of temporary suspension of growth activity. Such a state is called **dormancy.** . In plant physiology, dormancy is a period of arrested plant growth. It is a survival strategy exhibited by many **plant** species. It may be imposed by certain environmental factors or internal factors or genetic factors included.

Generally plants or plant structures, in order to overcome or survive against hostile environmental conditions undergo a period of dormancy with suitable modifications. In lower plants production of endospores, zygospores, auxospores, akinetes, etc, are some of the methods involved in tiding over unfavorable conditions. Even vascular plants with their complex structural organization and reproductive methods produce dormant structures to overcome unfavorable conditions. Some of the dormant structures that develop in plants greatly facilitate in the dispersal mechanism.

Bud Dormancy

Perennial plants like shrubs, trees have to go through different seasons in a year. The onset of winter is always an unfavorable season for the growth and even survival of plants become difficult because of extreme variations in the temperature, especially cold conditions. In order to survive against such hostile conditions the growth regions like apical buds, axillary buds and underground structures like rhizomes, tubers, etc, undergo a period of dormancy "suspended growth". It is during this season that leaves wither. In fact, it is not the change in the temperature that acts as the signal but it is the change in the photoperiodic conditions which triggers the falling of leaves.

It is again during the same season, meristematic cells found in the buds undergo temporary suspension of their activities. In addition to it, the meristematic regions will be armed and protected with a number of leaves called bud scales which are thick, waxy and covered with a dense coat of hairs. Such structures provide thermal insulation to the meristematic zones and prevent them from cold injury or frost bite.

Site of Perception:

Though leaves perceive changes in photoperiodic effects of the day, it is the buds that act as the sites of perception for inducing dormancy. The induction of dormancy in buds starts only after the falling of leaves. Nonetheless, in many plants even old leaves act as the sites of perception in inducing bud dormancy. Such buds can be induced to break the dormancy by subjecting the same to long photoperiodic treatment or interrupting the long dark periods by red light.

Mechanism of Induction of Dormancy in Buds:

*The onset of short day or long dark photoperiods in winter stimulates the synthesis of various growth inhibiting compounds of which Abscissin dominates. Quantitative estimation by solvent extraction methods reveal that dormant buds contain greater amounts of ABA than actively growing buds. Abscissin is a well known growth inhibiting hormone. By inhibiting the synthesis of proteins, RNA and other metabolic processes, ABA imposes dormancy on meristematic tissues of the plant body.

*The involvement of photoperiodic effect on bud dormancy indicates that the phytochromes have a role in imposing dormancy. Phytochromes are known to be present in plastid membranes and other surface membranes. It is also known that ABA is synthesized and often stored in plastids. Phytochromes by perceiving the changes in photoperiodic conditions probably induce the synthesis of ABA and also facilitate the release of ABA. Then ABA is translocated to the buds where it brings about temporary suspension of metabolic activities and totally inhibits mitotic activity. The presence of Abscissin, which is also called 'Dormin' has been detected from various plant structures involved in dormancy ex., dormant potato tubers, birch leaves, winter buds in clerodendron, pinus, etc.

Breaking Bud Dormancy:

The dormant buds can be induced to sprout again by treating with cytokinins and gibberellins. But in natural course, the onset of spring and long photoperiods, the dormant buds become active and develop into branches.

Cytokinins are known to be synthesized in root tips but under cold conditions because of the snow fall, the root meristems are very inactive and they don't synthesize sufficient quantities of cytokinin required for the buds to be active. That is probably one of the reasons why buds remain dormant. As soon as cytokinins are provided to dormant buds, mitotic activity is initiated and buds start sprouting. Besides, cytokinins also counteract ABAs inhibitory effect of the metabolic activity level and promote growth activity.

Another class of phytohormones, which overcomes the bud dormancy, is Gibberellins. Now it is certain that Gibberellin synthesis takes place in plastids. Moreover, the synthesis of GA and ABA starts from the same precursor called mevolonate. Under short day conditions, the pathway from mevolonate is directed towards ABA synthesis and GA synthesis is inhibited, but during long day photoperiods it is directed towards GA synthesis and ABA synthesis is blocked. Hence gibberellins under long day conditions or not light treatment, break bud dormancy and nullify the effect of ABA present in such dormant buds.

Seed Dormancy

Definition of Seed Dormancy:

Seed dormancy or rest is the innate inhibition of germination of a viable seed even placed in most favourable environment for germination.

Reasons of Seed Dormancy:

1. Immaturity of Embryo:

Embryo is immature at the time of seed shedding. The seed will remain dormant till the embryo becomes mature, e.g., Anemone nemorosa, Ranunculus ficaria.

2. After-Ripening:

The seeds require a period of dry storage for developing the ability to germinate, e.g., Wheat, Oat, Barley.

3. Impermeable Seed Coat:

The seed coat is impermeable to water and gases, e.g., Apple, Chenopodium.

4. Hard Seed Coat:

The seed coat is mechanically resistant and does not allow the embryo to grow, e.g., Amaranthus, Lepidium.

5. Germination Inhibitors:

They occur in the seed coats and cotyledons of the embryos. The important germination inhibitors causing seed dormancy are abscisic acid, phenolic acid, ferulic acid, coumarin, short fatty acids and cyanogenic chemicals, e.g., Apple, Peach, Ash, Cucurbita, Iris, Xanthium.

Natural Breaking of Seed Dormancy:

In nature seed dormancy is broken automatically due to:

(i) Development of growth hormones to counter growth inhibitors,

(ii) Leaching of germination inhibitors,

(iii) Maturation and after-ripening of embryo,

(iv)Weakening of impermeable and tough seed coats by microbial action, abrasion, passage through digestive tract of animals, etc.

Artificial Breaking of Seed Dormancy:

Methods of breaking seed dormancy

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 scarification.

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

i) Mechanical scarification

It is simple and effective if suitable equipment is available.

Chipping hard seed coat by rubbing with sand paper, cutting with a file or cracking with a hammer are simple methods useful for small amount of relatively large seeds. For large scale, mechanical scarifiers are used. Seeds can be tumbled in drums lined with sand paper or in concrete mixers containing coarse sand or gravel. The sand gravel should be of a different size than the seed to facilitate subsequent separation. Scarification should not proceed to the point at which the seeds are injured and inner parts of seed are exposed.

ii) Acid scarification: Dry seeds are placed in containers and covered with concentrated Sulphuric acid (H_2SO_4) or HCl in the ratio of one part of seed to two parts of acid. 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 10 minutes to 6 hours depending upon the species. At the end of the treatment period, the acid is poured off and the seeds are washed to remove the acid. The acid treated seeds can either be planted immediately when wet or dried and stored for later planting. Large seeds of most legume species, brinjal and tomatoes are reported to respond simple sulphuric acid treatment

iii)Hot water scarification: Drop the seeds into 4-5 times their volume of hot water with temperature ranging from 77 to 100oC. 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.

b. Stratification:

Stratification 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.

i)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.

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 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°C. At higher temperature seeds sprout prematurity and low temperature delays sprouting.

c) 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. Afterwards seeds are rinsed with water and are sown in the field. Similarly, potassium nitrate and sodium hypochlorite also stimulate seed germination in many plant species.

d) Hormonal treatment •Among various hormones, GA3 (Gibberellic acid) is commercially used for breaking seed dormancy in different types of seeds. The concentration of GA3 depends upon the kind of seed but generally a concentration of 200-500 ppm is most widely used. • Cytokinin is another group of hormones used for breaking physiological dormancy and stimulating germination in seeds of many species. Kinetin and BA(6-benzyle aminopurine) are commercial preparations of cytokinin used for breaking seed dormancy

Importance of Seed Dormancy:

1. Perennation:

Seed dormancy allows seeds to pass through drought, cold and other un-favourable conditions.

2. Dispersal:

It is essential for dispersal of seeds.

3. Germination under Favourable Conditions:

Seeds germinate only when sufficient water is available to leach out inhibitors and soften the seed coats.

4. Storage:

It is because of dormancy that human beings are able to store grains, pulses and other edibles for making them available throughout the year and transport to the areas of deficiency.