Lecture-3

Seed Dormancy: Methods of breaking seed dormancy

Learning objectives

- To know about techniques for breaking different types of dormancy

Several methods are used for breaking seed dormancy of horticultural crops. These are briefly described hereunder:

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 amount of seed treated at any time should be restricted to not more than 10kg 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 10 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 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 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 and peaches) 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.

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.
- However, temperate species displaying epicotyl dormancy (like fringed tree) or under developed embryo (like hollies) a warm stratification of several months followed by a moist chilling stratification is required.

- Several tropical and subtropical species (like palms) require a period of warm stratification prior to germination to allow the embryo to continue development after fruit drop.
- The seeds can be sown after fruit drop. The seeds can be sown immediately after stratification in the field.
- 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 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.

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(Plate 3.3).
- 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^{o}C. At higher temperature seeds sprout prematurity and low temperature delays sprouting.
- The medium should be remoistened. The stratified seed is separated from the medium prior to sowing in nursery beds.

- The stratification of seeds results in quick and uniform germination and therefore the seed should be subjected to stratification invariably under all conditions.

Table 3.1. Effect of seed stratification period on per cent germination of important temperate fruits

Kind of fruit	Stratification period (days)	% germination
Apple	70-75	70-75
Kainth (*Pyrus pashia*)	30-35	90-95
Peach	60-70	55-60
Apricot	45-50	75-80
Almond	45-50	85-90
Walnut	95-100	80-85
Pecan	70-75	75-80

iii) 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 seed germination.

iv) 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.

v) 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.

vi) 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 polyglycol (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 to protect the seeds from pathogens. After this, the seeds are washed and dried at 25^0C 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.

vii) 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.

viii) Hormonal treatment

- Among various hormones, GA_3 is commercially used for breaking seed dormancy in different types of seeds. The concentration of GA_3 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. Soaking seeds in 100 ppm solution of kinetin for 3-5 minutes is highly effective concentration for overcoming seed dormancy of many species. Etheral also stimulates germination in seeds of some species.

Table 3.2. Recommended concentrations of growth hormones in temperate fruits for increasing seed germination

Crop	Chemical/hormone	Concentration
Apple	Thiourea	5000ppm
	Kinetin	25ppm
	GA	50ppm
	Ethrel	100-200ppm

Pear	GA	150ppm
	Thiourea	5000ppm
Peach	Thiourea	5000ppm
	GA	400ppm
	BA	400ppm
Walnut	GA	250ppm
	Ethrel	1000ppm

Hormonal changes during stratification:

A triphasic change in endogenous hormones is many seeds is depicted in Fig.3.1.

- A reduction of ABA
- Increased synthesis of cytokinin and gibberellins
- Reduction in hormone synthesis in preparation for germination.

- In general, gibberellins promote germination in dormant seeds, while ABA inhibits germination.
- Pre-sowing treatments with certain seeds not only reduce the stratification requirement and improve the seed germination but also enhances seedling growth in a number of temperate fruits.

Role of hormones in seed dormancy:

Plant hormones affect seed germinations and dormancy by affecting different parts of the seed. Embryo dormancy is characterized by a high ABA/GA ratio, whereas the seed has a high ABA sensitivity and low GA sensitivity. To release the seed from this type of dormancy and initiate seed germination, an alteration in hormone biosynthesis and degradation towards a low ABA/GA ratio, along with a decrease in ABA sensitivity and an increase in GA sensitivity needs to occur.

- Plant regulators can be used to break or prolong the dormancy. Sprouting of potato tubers and onion bulbs is a common phenomenon in storage.
- Pre-harvest spray of maleic hydrazide (MH) at 2000 ppm applied 15 days before actual date of harvest prolongs dormancy in the above storage organs by inhibiting the sprouting.
- In fruit trees of apple, plums and figs, early flowering is induced by spraying Dinitro orthocresol at 0.1 % in oil emulsion.
- Seed treatment of tomato with GA at 1 00 ppm breaks the dormancy and increases the percentage of germination.

- ABA controls embryo dormancy, and GA enhances embryo germination. Seed coat dormancy involves the mechanical restriction of the seed coat, this along with a low embryo growth potential, effectively produces seed dormancy.
- GA releases this dormancy by increasing the embryo growth potential, and/or weakening the seed coat so the radical of the seedling can break through the seed coat. Different types of seed coats can be made up of living or dead cells and both types can be influenced by hormones; those composed of living cells are acted upon after seed formation while the seed coats composed of dead cells can be influenced by hormones during the formation of the seed coat.
- ABA affects testa or seed coat growth characteristics, including thickness, and effects the GA-mediated embryo growth potential. These conditions and effects occur during the formation of the seed, often in response to environmental conditions. Hormones also mediate endosperm dormancy.
- Endosperm in most seeds is composed of living tissue that can actively respond to hormones generated by the embryo. The endosperm often acts as a barrier to seed germination, playing a part in seed coat dormancy or in the germination process.
- Living cells respond to and also affect the ABA/GA ratio, and mediate cellular sensitivity; GA thus increases the embryo growth potential and can promote endosperm weakening. GA also affects both ABA-independent and ABA-inhibiting processes within the endosperm.