RAMA UNIVERSITY

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# FACULTY OF AGRICULTURAL SCIENCES

# AND ALLIED INDUSTRIES

## CHARACTERISTICS OF GOOD QUALITY SEED

1. It must be genetically pure:

   Breeder /Nucleus - 100%genetic purity

   Foundation seed - 99.5%

   Certified seed - 99.0%

2. It should have the required level of physical purity for certification

   All crops - 98%physical purity

   Carrot - 95%

3.It should have high pure seed percentage

Bhendi - 99.0 %

Other crops - 98.0 %

Sesame, soybean &jute -97 .0 %

Ground nut -96.0 %

4.It should be free from other crop seeds, expressed in number /kg

| **Crop** | **Designated inseparable other crop seeds** |
|---|---|
| Barley | Wheat ,oats &gram |
| Oats | Wheat ,gram & barley |
| Wheat | Oats, gram &barley |

# SEED DORMANCY

It is the resting stage (or) survival mechanism of the seed because dormancy delays germination, therefore it is of great importance and effectiveness as a survival mechanism.

According to Amen (1963) he defined dormancy as "endogenously controlled but environmentally imposed and it is the temporarily suspension of growth accompanied by reduced metabolic activity and relatively independent of ambient environmental conditions.

Based on Amen (1963) definition, the dormancy can be classified in to two

A. Innate dormancy / Primary dormancy

B. Secondary dormancy

**A. Innate dormancy / primary dormancy**

It is the state of the seed as the seed dispersed from the mother plant i.e. the dormancy may be induced before maturity, during maturity and after maturity but before seed is dispersed from mother plant.

**B. Secondary dormancy**

Secondary dormancy can take place only in a matured and imbibed seed by certain environmental conditions, which are unfavourable to germination. e.g) Spring wheat and winter barley , the secondary dormancy could be imposed by

1) Exposure of dry barely seed to temperature between 50-90 $^{o}$C

2) Seven day storage of winter barely at high moisture containers at 20$^{o}$C.

3. One-day storage of spring wheat at high moisture content in airtight containers at 50$^{o}$C.

4. Placement of seed under water and in darkness for one to 3 days at 2$^{o}$C.

Induction of secondary dormancy was possible one and half months after physiological maturity.Secondary dormancy in spring wheat could not be broken by two weeks of storage. However it was completely broken by 0.1GA, 0.5 to 1.0 Ethanol, low temperature stratification's, removal of pericarps and storage at 20$^{o}$C.

**SECONDARY DORMANCY MECHANISM**

1. Imposition of blocks of crucial points in the metabolic sequence leading to germination.

2. An unfavourable balance of growth promoting versus growth inhibiting primary dormancy (coat imposed dormancy)

In many species seed dormancy is imposed by the structures surrounding the embryo (seed coat), which may include glumes, palea and lammae (grasses, the pericarp, perisperm and endosperm). The embryo in these cases are non dormant one.

**Mechanism of prevention of embryo germination by seed coverings**

(Bewley and Black, 1982)

1. Interference with water uptake

2. Interference with gaseous exchange

3. Pressure of chemical inhibitors

4. Seed coat as barrier for release of inhibitors from the embryo

5. Modification of light reaching the embryo

6. Seed coat exerting mechanical restraint

**A. Barrier effect and permeability changes - imposed by seed coat**

• **Seed coat impermeable to $O_2$**

As a consequence of seed coat in limiting the amount of oxygen available to the embryo, the respiration needed for germination would also be affected, enforcing the embryo to remain dormant. The isolated embryo of some seeds are, however, capable of germinating under extremely low oxygen tensions and even under nitrogen. The deleterious effects of low oxygen levels may also be attributed to factors other than reduced respiration such as the production of inhibitors or the failure to oxidize inhibitors already present. eg. *Sinapis arvensis* contains mucilagenous seed coat.

• **Seed coat impermeable to water**: Leguminous seeds eg., Pulse seeds.

These type of seeds are called " Hard seeds" which has interesting mechanism that regulate water uptake. The water uptake is restricted in these seeds (Leguminous) due to the presence of strophiolar cleft in the micropylar region.

The hilum is also impervious to water, and under moist conditions, the fissure in the hilum is closed but tends to open only in a low relative humidity. The device plays an important role in the drying of the seed, including its tests, resulting in the establishment of its impermeability to water. The strophiole also does not conduct water unless the seed has experienced certain conditions at which point it becomes the major site for the entry of water. eg. Leguminous and Malvaceae family seeds.

Imbibition can occur only after the cleft has been unplugged by impaction, sulphuric acid treatment, or natural causes such as temperature fluctuations, wetting and drying, soil acidity, micro organisms, passage through the digestive tracts of animals or by natural aging.

Seed hardens also due to certain process such as

i) Calcification - More Calcium accumulation

ii) Lignification - More lignin accumulation.

iii) Pectinization - More pectic substances accumulation

iv) Subernization - Faster elimination of moisture from seed.

(Seeds without hilum: strophiolar plug) (Seeds with hilum: hilum fissure)

- **Seed coat impermeable to light**

Many light sensitive seeds posses seed coat imposed dormancy. Naked embryos germinate irrespective of the light /dark conditions, with only a few showing true embryo dormancy. Instant light requiring seeds can be stimulated to germinate when a certain ratio of Pfr (active) and Pr (in active) forms of phytochrome (p) is established with in the embryo by the influence of red and far - red lights; the ratio depends upon the plant species. Since the light must pass through the surrounding tissues (coat) enclosing the embryo, they could act as filter, altering the proportion of Pfr and Pr radiation reaching the embryo. Thus in addition to coat imposed dormancy, the embryo of light sensitive seeds may also suffer from an inadequate light environment, resulting in dormancy. The coat thickness and pigmentation, as affected by the environment during the development of seed on the mother plant modify the coat to act as a light filter. Seeds with thick dark coats are comparatively less responsive to light than those with thin, light coated seeds. eg. *Chenapodium album.*

In case of lettuce (Lacutca sativa) the endosperm imposes dormancy by acting as a mechanical barrier against germination, unless hydrolases (cellulose and pectin - hydrolyzing enzymes) are synthesized to newly to weaken to the mechanical barrier of these polymers.

**D. Relative dormancy**

These type of dormant seeds exhibit dormancy at one particular temperature , while not exhibiting dormancy at another.

e.g. Wheat grains are usually dormant for a short while after harvest and will not germinate at $20^{o}$C temperature. If the temperature is lowered to $15^{o}$C, nearly all the grains germinate. After the loss of dormancy, germination occurs at both temperatures. This is called relative dormancy.

**Quiescence seed**

Germination is presented by the absence of the basic conditions required for normal germination and growth. e.g. Insufficient water in air dry seed.

**Changes in dormancy**

Primarily dormant seeds, either dry or imbibed, require exposure to a certain temperature for a certain period to releive dormancy. Only then the seeds become sensitive to factors that stimulate germination. However, germination will occur only when the complete set of required factors is present. If not germination will be imbibed. Which can be broken under suitable temperature conditions.

**Advantages of dormancy**

1. Storage life of seed is prolonged
2. Seed can pass through adverse situation
3. Prevents the *insitu* germination.

**Disadvantages**

1. Long periods of time needed to overcome dormancy (for uniform germination)
2. Germination trays exit over time
3. Contributes to longevity of weed seed.
4. Seed testing problems
5. While raising a crop it is very difficult to maintain the population in the field.

**OTHER TYPES OF DORMANCY**

I. Embryo dormancy

II. Presence and absence of inhibitors (chemical dormancy)

III. Combination of dormancy.

**I. Embryo dormancy**

It may be due to either a deficiency in the axis (immature embryo) or some metabolic block's within in cotyledons (dormant embryo).

a) Immature embryo

b) Dormant embryo

**a) Immature embryo**

The embryo of seed is not fully matured it needs after ripening period or otherwise it leads to dormancy. This type of dormancy is linked with other requirement of special temperatures. e.g. Oil palm, Anona and Hog weed.

Rudimentary / immature embryo is present, it requires after ripening period for it full growth and germination.

**After ripening period**

In some seeds, which are dormant when shed from the parent plant, gradually loose their dormancy if they are kept in dry conditions (ambient conditions). e.g Wild oat, it required chilling treatment (5 $^{o}$C) for breaking dormancy. It will lose their chilling requirement if kept in dry conditions for 30 months.

**b) Dormant embryo**

Seed and embryo fully matured but embryo shows dormancy. The dormancy of embryo is due to the blockage of metabolism operating with in the embryo itself.

**II. Chemical dormancy**

Presence of inhibitors with in the seed can cause dormancy. To break this type of dormancy seeds can be treated with growth promoters (or ) of inhibitors can be done. Inhibitors present in the coat of some seeds (Bewles and Black, 1982).

| S.No | Species | Location of inhibitor | Name of inhibitor |
|---|---|---|---|
| 1 | *Gossypium spp.* | Pericarp, testa | Absicic acid (ABA) |
| 2 | *Corriandrum sativum* | Pericarp | Coumarin |
| 3 | *Helianthus annus* | Pericarp, testa | Hydorcyanic acid |
| 4 | *Oryza sativa* | Hull | Probably ABA |
| 5 | *Triticum spp.* | Pericarp, testa | Catechin, catechin tannins, several unknowns |
| 6 | *Hordeum vulgare* | Hull | Coumarin, Phenolicacids. scopoletin |
| 7 | *Elaegnus angustfolia* | Pericarp, testa | Possibly coumarin |

| | | | |
|---|---|---|---|
| 8 | *Beta vulgaris* | Pericarp | Phenolic acids, Possibly ABA, high concentration of inorganic ions. |
| 9 | *Avena sativa* | Hull | Unknown. |

**II. Combination of dormancy**

Combination of more than one type of dormancy posed by the same seed needs more than one treatment to break the dormancy.

e.g. European ash tree seed and woody trees and shrubs of temperate regions. The dormancy is due to immature embryo and hard seed coat, this seed requires chilling treatment with $5^{o}C$ for 4 months along with softening of seed coat.

**Dormancy breaking treatments**

(Exogenous and endogenous dormancy)

1. Scarification treatments (Acid scarification , Steam scarification , Mechanical scarification)
2. Stratification treatments (Warm stratification & Cold stratification)
3. Hot water treatment
4. Leaching of metabolites (inhibitors)
5. Temperature treatments a) Low b) High c) Alternate and d) Fire
6. Light treatment
7. Pressure treatment
8. Infra red radiation treatment
9. Magnetic treatment
10. Promoters and inhibitor concept.

**Classification of seed dormancy**

| S.No | Types | Causes | Embryo characteristics | Pre-treatment |
|---|---|---|---|---|
| 1 | Physiological | Physiological inhibiting mechanism of germination in the embryo | Fully developed dormant | Seed soaking in growth regulators ($GA_3$, Ethrel, and chemical solutions (KNO3, Thiourea) |
| 2 | Physical | Seed coat impermeable | Fully developed, non-dormant | Scarification (Mechanical and con. H2SO4 treatment) |
| 3 | Combinations | Impermeable seed coat, physiological inhibiting mechanism of germination in the embryo | Fully developed dormant | Scarification followed by chemical treatment |
| 4 | Morphological | Under developed embryo | Under developed - non-dormant | Cold stratification |

| | | | | |
|---|---|---|---|---|
| 5 | Morpho-physiological | Under developed embryo, physiological | Under developed dormant | Stratification followed by chemical soaking. |

**1. Scarification**

Any treatments may be physical or chemical that weakens or softens the seed coat is known as scarification. This method is more applicable to Malvaceae and Leguminaceae group of seeds.

**a) Acid scarification**

By using concentrated $H_2SO_4$ 100 ml /kg of seed for 2-3 minutes treatments can be overcome dormancy in the above group of seeds. The duration of treatment will vary and it depends on type and nature of seed coat.

E.g. Tree crops 1-3 hours, Rose seeds, treat the seed partially with acid and then given with warm stratification.

**b) Mechanical scarification**

Seeds are rubbed on a sand paper or with a help of mechanical scarifier or by puncturing on seed coat with the help of needle to enhance / increase the moisture absorption by seeds.

E.g. Bitter gourd for sand scarification sand and seed 2:1 ratio should be followed. Rub against hard surface of seed for 5 to 10 minutes.

**c) Stream scarification**

The treatment can be given for about 15-20 minutes . Seeds can be kept in the way of boiled steam and dormancy can be broken.

**2. Stratification treatment**

When seed dormancy is due to embryo factor, seeds can be subjected to stratification treatments.

**a) Cold stratification**

Incubate the seed at low temperature of 0-5 $^{o}$C over a moist substratum for 2-3 days to several months. It depends on the nature of seed and kind of dormancy. eg.. Cherry and oil palm seeds.

**b) Warm stratification**

Some seeds require temperature 40-50 $^{o}$C for few days e.g. paddy. In case of oil palm it requires temperature of 40-50o C for 2 months for breaking dormancy. Care should be taken during the treatment and moisture content of seed should not be more than 15%.

**3. Hot water treatments**

It is effective in case of leguminous tree crop seeds. The seeds should be soaked in boiled water for 1-5 minutes to 60-80 minutes. Some crops like Bengal gram and Groundnut, hot water treatment for more than 1 minute is found injurious to seed.

**4. Leaching of metabolites ( Iinhibitors )**

The seeds can be soaked in water for 3 days. But once in12 hours fresh water should be changed to avoid fermentation or seeds can be soaked in running water for a day to leach out the inhibitors.

**E.g.** Coriander (Coumarin), Sunflower, (Hydrocyanic acid)

**5. Temperature treatments**

**a) Low temperature treatments**

Plants, which grow in temperature and cooler climates, require a period of chilling for breakage of dormancy.

E.g. Apple seed dormancy can be released by low temperature treatment by storing the seeds at $5^{o}$C.

**b) High temperature treatment**

Normally high temperature treatments are exhibited by early flowering "winter " annuals.

E.g. Blue bell (*Hyacinthoides nonscripta*). Their seeds are shed in early summer and do not germinate until they have been exposed to the heat to high summer.

**c) Alternate temperature treatments**

Most of the plant species which grow in temperature and cool temperate regions require alternate temperature for breakage of dormancy eg. Bull rush (Typha).

**d) Fire treatment**

Many shrubs and trees of sub tropical and semi-arid regions have extremely hard seeds in which the seed coat is very impervious to water. Dormancy in such seeds is clearly coat imposed, and maybe broken by exposure to extreme heat such as fire.

E.g. Seeds of C*alluna vulgaris* - dormancy is broken by fire.

**6. Light and phytochrome**

Red light (670 nm )

Inactive from of Pr Pfr Activeform of Phytochrome (non dormant)

Phytochrome (Dormant)

(Blue green incolour) Far red light(730nm) (Yellowish green in colour)

Red light promotes germination and far red light affects germination.

**7. Promoters inhibitors concept**

For regulation of germination the promoters and inhibitors present in the seed should be in a balanced manner.

- GA stimulates NRNA's activity, thereby helps in translocation of food reserve materials to active site of meristematic activity. GA also helps in cell division.
- Cytokinin is a natural endogenous hormone which controls germination through DNA to RNA transcription system.

• Abscisic acid is an inhibitor that can present germination by affecting RNA synthesis.

**8. SEED TREATMENT WITH GROWTH REGULATORS /CHEMICALS**

If the endogenous dormancy is due to the presence of inhibitors, we can apply growth regulators at the low level to break dormancy.

- GA & Cytokinin and kinetin can be used at concentration of 100-1000 ppm to break dormancy. GA is light substituting chemical. $KNO_3$ 2% can be used for breaking the dormancy of light requiring seeds eg., Oats, Barley and Tomato.
- Thiourea can be used for breaking dormancy of both light and chilling treatment requiring seeds e.g. lettuce, con. of thiourea is $10^{-2}$ to $10^{-3}$ molar.
- Ethrel can be used for breaking the dormancy of cotton seed. The dormancy in cotton seed is due to the presence of ABA in pericarp of seed.
- Nitrogenous compounds like thiourea, hydroxylamine, Nitric acid, nitrtate, can also be used for breaking dormancy.
- Sulphidral compounds like 2 mercapto ethanol and 2,3 dimercapto ehtanol can also be used.
- Plant products like strigol (root exudation from striga parasite host plant) can also be used for breaking the seed dormancy.

**9. Infra red radiation treatment**

Infra red rays can be passed on to the seeds and dormancy can be released.

**10. Pressure treatment**

Dormant seeds can be kept in autoclave and required pressure can be employed for breaking dormancy.

**11. Magnetic seed treatment**

Seeds can be kept in the magnetic field for about 1 to 10 days for breaking dormancy.

IMPORTANT QUESTIONS:

1. Describe components of seed and their role.
2. What is quality seed? Describe main characteristics of quality seeds.
3. Explain seed dormancy and the mechanisms to break seed dormancy.
4. Briefly explain different types of seed dormancy and advantages of dormancy.