Methods of Plant Propagation

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To,
Fifth semester students

Seed/Sexual propagation

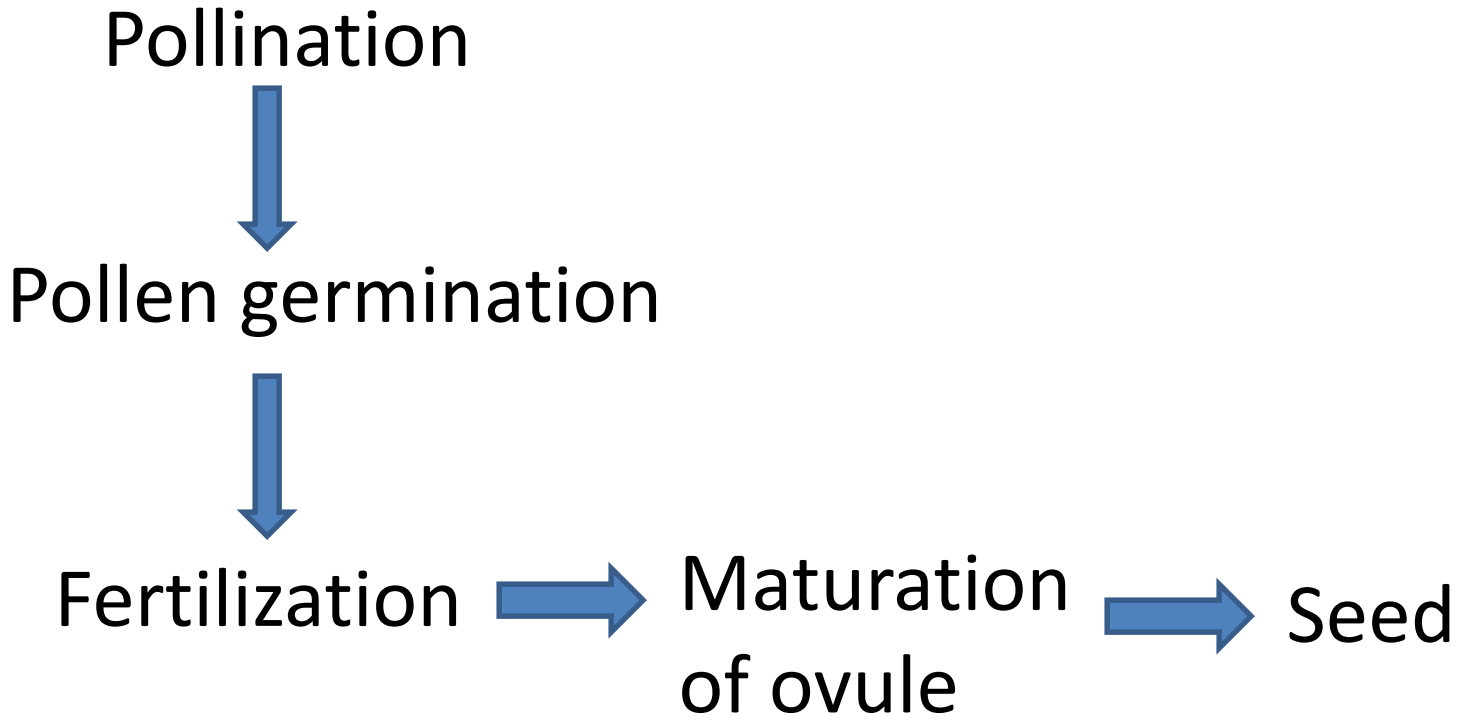
Propagation through seed production.

Advantages

- Brings about genetic variation in populations.
- Seedlings are easy to handle and store.
- Easily mechanized on a commercial level.
- High disease resistance
- Adaptation to extreme climates.
- Early flowering
- Maximum yield.

Seed propagation - Aspects

Seed formation



Seed certification

- **Seed certification** is a quality assurance system whereby **seed** intended for marketing is subject to official control and inspection.
- Breeder seed
- Foundation seed
- Registered seed
- Certified seed

Breeder Seed

- **Breeder Seed** is the original source of all classes of certified **seed**.
- It is held, maintained, and controlled by the originating plant **breeder**, sponsoring plant **breeder** or institution, in such a way to maintain its genetic purity and identity.

- **Foundation seed** is **seed** so designated by an agriculture experiment station. Its production must be carefully supervised or approved by representatives of an agricultural experiment station.

- Registered seed is the foundation seed, distributed to registered seed growers to be increased further for distribution. Registered seed is normally grown for the production of certified seed.

- **Certified seed :** The progeny of foundation seed produced by registered seed growers under supervision of seed certification agencies to maintain the seed quality as per minimum seed certification standards.
- A blue colour certificate is issued by seed certification agency for this category of seed.

Analysis of seed quality

- Germination test
- Cold test
- Tetrazolium test
- Purity test

Germination test

- No.of seeds germinated.
- No. of healthy seedlings.

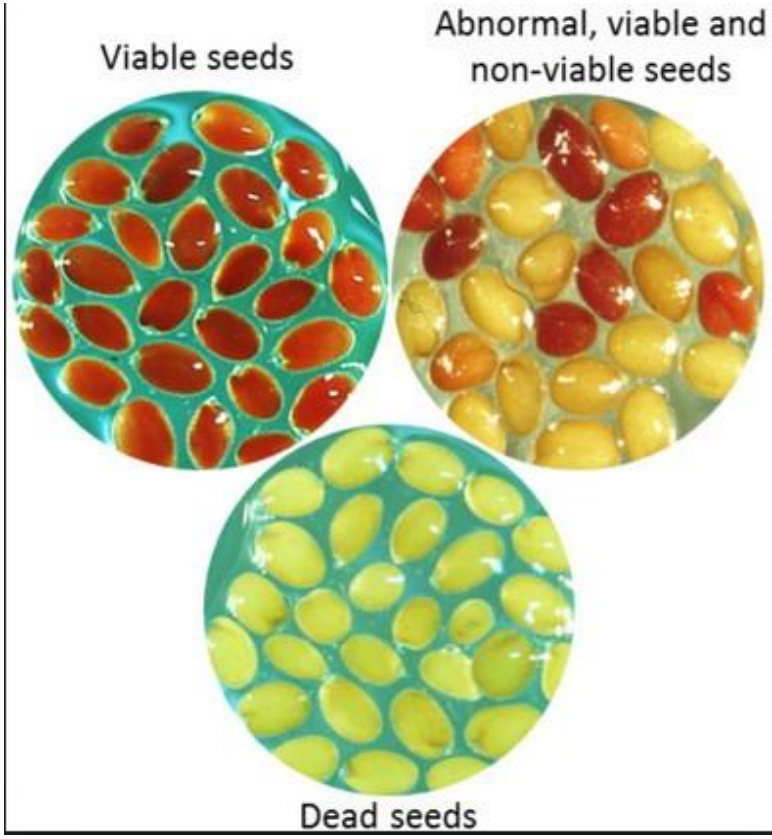
Cold test

- Prior to germination, Seeds exposed to Cold temp(below 10^{o}C).

- Higher germination % = Better seed quality

Tetrazolium test

- Salt used – 2,3,5-triphenyltetrazolium chloride.
- Middle cut seeds soaked in 0.1% TZ solution.
- Incubated in darkness at room temperature for 24 hours.
- If viable – Embryo stains pink (TTC transforms to insoluble red compound Formazon).
- If nonviable – Embryo colourless.



Purity test

$$\text{Purity percentage} = \frac{\text{Weight of pure seed}}{\text{Total weight of sample}} \times 100$$

High % pure seeds = High Purity=High quality seeds

Seed dormancy

- Inability or failure of viable seeds to germinate even under ideal environmental conditions due to internal causes.

TYPES OF DORMANCY

- Seed coat dormancy
- Dormancy due to rudimentary embryos
- Dormancy due to chemical inhibitors
- Dormancy due to internal factors
- Double dormancy etc..

SEED COAT DORMANCY

- It is due to the seed coats or other tissues covering the embryo which are hard & are impermeable to soil & oxygen which prevents germination.

  E.g. Malvaceae.

- Also the seed coats are apparently permeable to water & gases but they are so hard to resist the embryo expansion.

DORMANCY DUE TO RUDIMENTARY EMBRYOS

- Some plants shed their fruits before the embryo within the seed has attained the maturity stage to germinate.
- Such embryos require several weeks to several months after harvest to attain its full maturity so that it can germinate.

  E.g.. *Pinus sp., palms.*

DORMANCY DUE TO CHEMICAL INHIBITORS

- In certain species specific chemical substances that prevent germination occur in the seed coats, endosperm or the embryo.
- They are reduced or eliminated by leaching with water or adsorption of water.

DORMANCY DUE TO INTERNAL FACTORS

- It is due to physiologically dormant embryos.
- In this case, the dormant embryos do not resume active growth even though all environmental conditions are favourable, unless the seeds are subject to moist, chilling treatments.
- E.g. Freshly harvested seeds of apple, grapes, peach & apricot.

DOUBLE DORMANCY

- Seeds of some species exhibit both
  - seed coat dormancy &
  - embryo dormancy.

E.g. *Cercis occidentals* **(western redbud** or California redbud)

METHODS TO OVERCOME DORMANCY

- Mechanical scarification
- Soaking in water
- Acid treatment
- Cold stratification
- Dry storage
- Treatment with chemicals

MECHANICAL SCARIFICATION

- It includes breaking or scratching the seed coats mechanically to modify the hard or impervious seed coats.
- This can be done easily by revolving the seeds in a drum lined with sand paper.

SOAKING IN WATER

- Generally seeds will be soaked in hot water for a few seconds & then soaked for 24 hours in cold water which make the seed coat to get soften & wash off the incubators.

- In some case, the seeds are soaked in running cold water for a period of 8-12 hours which help in removing the inhibitors.

Acid treatment

- Soaking the seeds for a few seconds (15-60 seconds) in conc. Hydrochloric acid or sulphuric acid modifies the hard or impermeable seed covering.
- At the end of treatment period, the seeds are washed to remove the remnant acid.

COLD STRATIFICATION

- During stratification, seeds are exposed to abundant moisture, ample oxygen & a relatively cool temperature.
- It consists of placing the seeds in a moist medium of sand, peat or vermiculite & holding at a temperature slightly above freezing.
- This time varies between 1 to 4 months depending upon the type of seeds.
- This permits the physiological changes within the embryo to occur. During this process, the level of endogenous growth promoting substances (e.g.. Gibberellins & cytokinins) increase while the level of growth inhibiting hormones (e.g.. Abscissic acid) decreases, thus removing the block & permitting germination.

  E.g. Peaches

DRY STORAGE

- It promotes the after ripening in certain seeds which are dormant when freshly harvested.
- Freshly harvested seeds of many annuals & herbaceous plants fail to germinate until after a period of dry storage.
- Such post-harvest dormancy may last few days to several months.

TREATMENT WITH CHEMICALS

- Soaking in potassium nitrate (0.2%), gibberellic acid (200 to 500 ppm) or thiourea (0.2%) solution prior to sowing has been found to stimulate germination of different kinds of seeds.
- For instances, soaking of seeds in gibberellic acid stimulates the germination of many citrus species viz. Trifoliate orange, Rangpur lime, Sweet orange, Sour orange etc..

Biological Importance of Seed Dormancy

- 1. Dormancy allows the seeds to remain in suspended animation without any harm during drought, cold or high summer temperature.
- 2. 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.
- 3. It helps the seed to get dispersed over long distances through unfavourable environment or inhospitable area.
- 4. 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.
- 5. 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.
- 6. It follows storage of seeds for later use by animals and man.

Factor Affecting on Germination

1. Abiotic Factors:
   1) Light
   2) Temperature
   3) Aeration (Oxygen)
   4) Soil type and depth of sowing
2. Biotic factors:
   1) Viability of seed
   2) Dormancy period

Seed treatment

Treatment with Gibberellins:

- **Treatment** with high concentrations of GA is effective in overcoming dormancy and causing rapid germination of **seed**.
- Formation of male flowers = concentrations of 10 to 200 ppm.
- female flowers = 200 to 300 ppm*.

***ppm = mg/l**

Seed treatment

Treatment with cytokinins

- Kinetin(N^6-furfurylamino purine) +HCl+water.
- Higher plants – synthetic cytokinin(6-benzyl amino purine).
- Cytokinin+Gibberellin+ethylene = More efective.

Seed treatment

Treatment with ethylene

- Ethephon (ethrel)
- Fruit ripening

Seed priming

- Form of **seed** planting preparation in which the **seeds** are pre-soaked before planting.

Soaking seeds at 15 to 20^{o}C in aerated solutions of high osmotic strengths for 7 to 21 days.

Polyethylene glycol(20-30%), KNO_3, K_2HPO_4, Na Cl

Rinse seeds with distilled water

Air drying seeds at 25^{o}C and then storing until use

Thermotherapy/ Hot water treatment

- Dry seeds immersed in hot water (49 to 57^{o}C) for 15 to 30 minutes.
- After treatment, seeds are cooled and dried.

Aerated steam treatment

- Seeds treated in special machines in which steam and air are mixed and passed through steam mass.
- Prior to treatment –seeds kept in moisture saturated air at room temp.
- Treatment time – 10 to 30 min
- Temperature – 46 to 57^{o}C

Chemotherapy/Chemical treatment

Involves application of

- Chemical disinfestants (eliminate pathogens from seed surface)
- Disinfectants (eliminate pathogens from within the seeds).
- Protectants (Protect seeds from pathogenic fungi in the soil).

Infusion

- Introduction of chemicals such as growth regulators, fungicides, insecticides, antibiotics, herbicidal antidotes into seeds by means of organic solvents.

Seeds immersed in acetone & dichloromethane solution which contain the chemical to be infused. (1-4 hrs)

Solvent removed by evaporation

Seeds dried in vacuum desiccator

Methods of seeding

Direct seeding	Indirect seeding
One –step planting	Two-step planting
Seeds planted in field where they will germinate, grow, and go through the entire reproductive cycle.	Seeds sown in nursery upto seedling stage. Then transplanted to field.

DIRECT SEEDING

- Advantages
  - Well establishment of plants (undamaged vigorous root system)
  - No transplanting shock to the plant
  - Suitable method for short duration varieties
- Disadvantages
  - High weed growth if not controlled properly
  - Mechanical weed control is difficult
  - Seed wastage is high due to bird, rodent attack and flood, drought

Indirect seeding

Advantages

- greater control over growing conditions, such as protecting the soil from pests or allowing the seeds to germinate in a protected environment like a greenhouse.
- the success rate for indirect seeding is higher than direct seeding, and will therefore yield a greater crop.

Disadvantages

- lead to greater expenses due to the cost of materials such as seedling trays, or possibly even maintaining a greenhouse.
- requires additional preparation in order to make sure that your seedlings are ready for transplantation during the correct growing season.
- the young plants are at risk of transplant shock when you transplant them into a new, less-controlled environment.

Sowing of seeds

Methods of Sowing

- Broadcasting (seeds are just spread on the soil)
- Dibbling (placing of seeds in holes or pits at equal predetermined distances and depths).
- Drilling (dropping of seeds in holes, the seeds are then covered and compacted)
- Sowing behind the country plough (the seeds are placed into the furrows ploughed in the field either continuously or at specific distance manually by a man working behind plough)
- Planting (placement of seeds or propagules firmly in the soil for germination and growth).
- Transplanting (practice of planting seedlings in main field after pulling out from the nursery).

Zero tillage Seed Drill

Seed planting in the furrow created by the plough

Post/after-sowing care

- Watering (fine mist)
- Temperature maintenance(20 – 26^{o}C - in temperate countries)

Fertilizer application

- Weekly application
- Seedlings – low level application
- pH - 6 to 6.8

Hardening

- "**Hardening**" is the process of moving **plants** outdoors for a portion of the day to gradually introduce them to the direct sunlight, dry air, and cold nights.
- On a mild day, start with 2-3 hours of sun in a sheltered location.
- Protect **seedlings** from strong sun, wind, hard rain and cool temperatures.

Transplanting of seedlings

Transplanting is the practice of planting seedlings in main field after pulling out from the nursery.

Transplanting has a variety of applications, including:

- Extending the growing season by starting plants indoors, before outdoor conditions are favorable;
- Protecting young plants from diseases and pests until they are sufficiently established;
- Avoiding germination problems by setting out seedlings instead of direct seeding.