Course Teacher: **Dr. Rupendra Kumar Jhade**,
JNKVV, College of Horticulture,Chhindwara(M.P.)

B.Sc.(Hons) Horticulture- 1st Year, II Semester 2019-20
Course: Plant Propagation and Nursery Management

Lecture No. 11

Topic: Types and Stages of Seed Germination

1. **Seed:** A seed is a ripened ovule, which consists of an embryo and stored food supply surrounded by protected seed coverings.
2. **Embryo:** A miniature plant within a seed, produces by the union of male and female gamete.
3. **Germinate:** To being to grow.
4. **Germination:** The process in which seed embryo starts growing, which leads to the development of seedling.
5. **Dicots:** Plants having two cotyledons in their seeds.

The Process of Seed Germination:

The activation of metabolic machinery of seed embryo is the first and foremost step to initiate the seed germination process Thus, seed germination is the process of reactivation of the metabolic activity of the seed embryo, resulting in the emergence of radical (root) and plumule (shoot), thus leading to the production of a seedling or a young plant.

Seed germination is a very complex process as it involves many biochemical, physiological and morphological changes within a seed. For germination to be initiated, three conditions must be fulfilled **First,** the seed must be viable i.e the embryo should be alive and capable of germination. **Second,** the seed should be non-dormant i.e there should not be any dormancy or any chemical barrier for germination **Third,** the environmental conditions like moisture, temperature, air (O_2) and light must be available in appropriate amount. If all these conditions are fulfilled, the quiescent embryo in the seed will resume growth, thus initiating the process of germination. In the early stages of growth, the embryo draws nutrients from the stored food material in the cotyledons or the endosperm of Later, new shoot/leaves are developed, which produce their own photosynthetic system.

- **Stages of seed germination**: The process of seed germination involves several consecutive but overlapping events like
  i. absorption of water,
  ii. initiation of cell enlargement and division,
  iii. increased enzymatic activity,
  iv. food translocation to growing embryo,
  v. increase in respiration and assimilation,
  vi. increase in cell division and enlargement and
  vii. differentiation of cells into tissue and organs of a seedling.

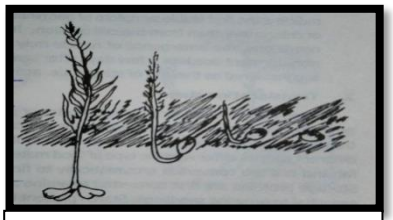

Fig 1: Different stages of seedling development

The sequence of these events is not specific and one event may overlap the other.However, the entire process of germination can be divided into following different stages:

1) Activation or awakening stage:

a) Water absorption: Early seed germination begins with the imbibition of water by the seed. Water is absorbed by the process of imbibition and osmosis by the dry seeds, which softens the seed coat and other coverings and causes hydration of the protoplasm. After imbibition of water, the seed swells and seed coverings rupture, which helps protoplasm in resuming metabolic activity with the activation of enzymes. During hydration phase, the seed coat acts as a limiting factor and its rupture increase water uptake. Water enters the seed through micropyler pore and hilum. In general, water absorption is very rapid initially but it slows down slowly and steadily.

b) Synthesis and activation of enzymes: After hydration, enzyme activity begins very quickly. Activation of enzymes is partly from reactivation of stored enzymes and partly by the synthesis of the enzymes during germination initiation process. The hydrolytic enzymes convert complex food material into simpler forms, which can be readily translocated and absorbed by the embryo. The oxidative enzymes are involved in respiration and releasing the energy for cell division and growth.

c) Cell elongation: Hydration, and synthesis and activation of enzymes help in the elongation of cells, which results in the emergence of radicle. Emergence of radicle is the first visible symptom of germination, which results from the elongation of cells rather than from the cell division. It is observed that under fabvourable conditions, the emergence of radicle may take place within a few hours as in non-dormant seeds or a few days after seed sowing. The emergence of radicle is considered as the end of stage 1 i.e. activation or awakening stage.

2. Translocation stage:

Food materials like fats, carbohydrates or proteins are stored in the endosperm or in the cotyledons. These compounds are converted into simpler forms and are translocated to the growing points of the embryo. The process of conversion of different speces differs with the type of food material reserved in the seed. For example, fat and oils are converted enzymatically to first to fatty acids and then to sugars. Storage proteins are first converted to amino acids and then to nitrogen, which are essential to growing seedlings. Starch present in many seeds as an energy source, is converted to simple sugars. All these conversions are regulated by metabolic activity of specific enzymes in a proper sequence.

3. Seedling growth stage:

In this stage, the development of the seedling plant takes place from continued cell division in different growing points of the embryo, which is subsequently followed by the expansion of the seedling structures.

The cell division is growing point and subsequent cell elongations are two independent processes taking place in a seedling. As the germination proceeds, the structure of seedling soon becomes evident.

- **Types of seed germination**:

The **radicle,** the growing point of root emerges from the base of the embryo axis and the **plumule,** the growing point of shoot is at the upper end of embryo axis, above the cotyledons.

The section of seedling stem above the cotyledons is called as epicotyl and below the cotyledons is called as hypocotyl.

Two types of germination are commonly found in cultivated plants.

1. **Epigeal germination:** Seed germination in dicots in which the cotyledons come above the soil surface.

In this type, the hypocotyl elongates and raises the cotyledons above the ground surface, it is called as epigeous or epigeal germination.

This type of germination is very common in beans, gourds, castor, tamarind and onion etc.

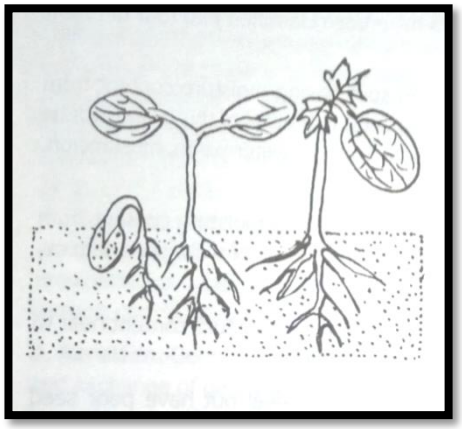

Fig 2: Epigeal Germination

2. **Hypogeal germination:** Seed germination in dicots in which the cotyledons remain below the soil surface.

In this type, the epicotyl elongates and the hypocotyl does not raise the cotyledons above ground, which is called as hypogeous or hypogeal germination.

This type of germination is common in mango, custard apple, pea, gram, lotus and maize etc.

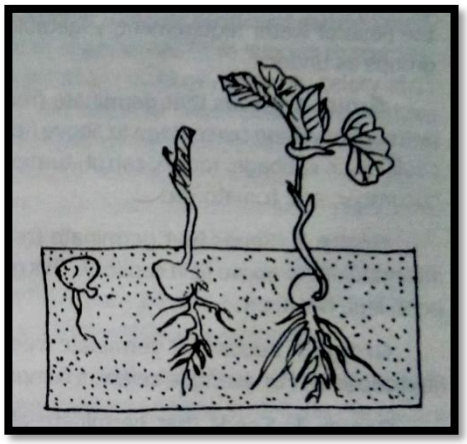

Fig 3: Hypogeal Germination

Source: Sharma RR & Manish Srivastav.2004. Plant Propagation and Nursery Management (First Edition 2004).International Book Distributing Co. Lucknow 226 004 U.P.(INDIA).