

Lecture-4

SEED PHYSIOLOGY

4.1 METHODS OF TESTING SEED VIABILITY AND VIGOR

There are several tests to evaluate viability and vigor in seeds. The tests intended to determine viability and vigor must meet certain principles. The ideal test should be

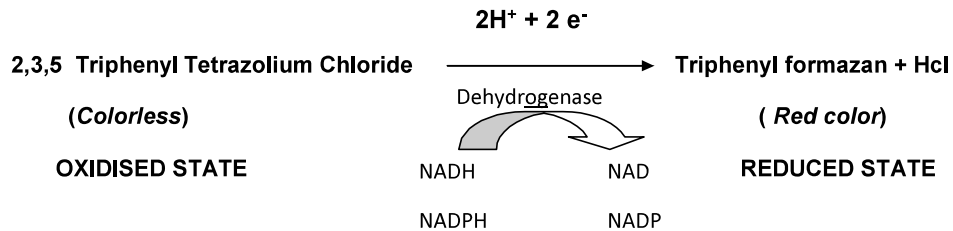
- ✓ Simple with out involving sophisticated equipment.
- ✓ Rapid- its procedure should take less time to give results.
- ✓ Effective in detecting minute as well as large differences.
- ✓ Equally useful for evaluating either individual seed or population of seeds.

4.1.1 VIABILITY TESTS:

A) Tetrazolium test: This test is often referred as a **quick test** since it can be completed with in hours. The test is usually based on measuring the activity of **dehydrogenase** enzyme in the tissues of embryo. It is conducted by using 2,3,5-Triphenyl Tetrazolium Chloride (TTC)solution.

Principle: Any living tissue must respire. In the process of respiration the enzyme dehydrogenase will be in a highly reduced state. When the seed is treated with colorless tetrazolium solution, the living tissue of the seed by virtue of respiration and having the dehydrogenase enzyme in a highly reduced state gives off hydrogen ions.

These hydrogen ions reduce the colorless tetrazolium solution in to red colored formazan. Thus, the tetrazolium test distinguishes between viable and dead tissues of the embryo on the basis of their relative rate of respiration in hydrated state.



B) Sulphuric acid test:This is usually a non- enzymatic test. The principle involved in this test is to distinguish the differential coloration of live versus dead tissue when exposed to sulphuric acid. The living portion of the cut surface of the seed develops **deep rose color** with in 5-10 minutes. Though this test takes less time, one must be careful in handling concentrated sulphuric acid.

A comparison between the above tests clearly indicates that tetrazolium test is more practicable, since it is quick and does not involve any risk.

4.1.2 VIGOR TESTS

a) Speed of Germination:

The speed of germination is an important aspect of vigor and provides a reasonably good index of vigor of any seed lot. Mathematically speed of germination is expressed as “**co-efficient of Germination**” (CG). Higher the value for speed of germination greater will be the vigor.

$$CG = \frac{100 (A_1 + A_2 + \dots + A_x)}{A_1 T_1 + \dots + A_x T_x}$$

A: Number of seeds germinated

T: Time corresponding to A

X: No of days to final Count.

b) Exhaustion Test:

This test is more suitable for cereal seeds. The moist paper toweling or crape craft paper used in this test has to be rolled loosely along with the seeds placed on the printed line of the paper. Those seeds which exhaust their reserve food material and produce seedlings with roots and shoots extending more than two inches are said to be vigorous.

c) Respiration Test :

Respiration is one of the important processes common to all living organism. In seeds the rate of respiration and vigor are closely related. Hence, it is natural assumption that seeds with high vigor would have higher respiration rates . The differences in respiration rates have been used to distinguish between high, medium and low vigor seeds in maize, wheat and soybean. This test can be used to detect loss of vigor due to mechanical damage, chilling, desiccation and other causes.

Other tests like **accelerated aging test (AAT)**, **Brick gravel test**, **Electrical Conductivity test** are also used to estimate seed vigor.

4.2 Mobilization and Utilization of Seed Reserves

Once seeds have imbibed water and are hydrated, metabolic functions begin to accelerate if dormancy was previously broken. Enzymes to become active upon hydration and are involved in mobilization of seed storage reserves. Once storage reserves are breaking down, they are moved as small molecules from the source to those cells or organs that have a need for the product. In general meristematic and actively growing cells are energy and nutrient sinks. In germinating seeds, cotyledons and endosperm are sources.

Stored sources of energy and nutrients include:

Starch: Starch is found in amyloplasts. Starch serves as a source of reduced carbon for respiration and metabolism. Enzymes involved in starch degradation are **β -amylase, α -amylase and Starch phosphorylase.**

Fats (oils): They are stored in fat bodies. The high energy content of fats is broken down by β -oxidation in glyoxysomes and used for respiration and metabolism.

Storage proteins: Stored in protein bodies. Storage proteins are rich in amino acids with abundant nitrogen and sulfur. Amino acids rich in N are asparagine, glutamine and lysine. Sulfur-containing amino acids are methionine and cysteine. Storage proteins are broken down by aminopeptidases, carboxypeptidases, and endopeptidases.

4.3 MORPHOLOGICAL, PHYSIOLOGICAL AND BIOCHEMICAL CHANGES DURING SEED GERMINATION:

Seed germination is the resumption of active growth of the embryo that results in the rupture of the seed coat and emergence of the young plant. During the process of germination seeds undergo several metabolic changes. These changes can be summarized as follows.

- Initially the seeds imbibe water through the openings in the seed coat. Upon **imbibition** the cells become turgid, the seed increases in its size/volume and the seed coat becomes more permeable to diffusion of gases (O_2 and CO_2).
- There will be a change in the sub cellular organization of the embryo, endosperm and aleurone layer.
- Phytochrome becomes biologically active and triggers the process of germination in some plant species.
- The tissue of rehydrated seeds activate the enzymes which help in
 - Hydrolysis or break down of storage food material (starch, proteins and fats)
 - Transfer of nutrients from cotyledons and endosperm to the growing points
 - Utilization of hydrolyzed products in the synthesis of new material
- Following the activation of enzymes, the embryo initiates growth in terms of cell division and elongation
- The hormones (GA, Auxins and Cytokinins) necessary for germination will be synthesized or activated.
- Growth of the root-shoot axis occurs at the expense of the storage tissue.

- The enlarging root-shoot axis exerts internal pressure on the seed coat and results in its rupture. In case of dicots the pressure developed between the cotyledons helps in rupturing of the seed coat and emergence of growing point.
- It is primary root that emerges first and supports in the establishment of seedling
- Finally, the seedling establishes and becomes autotrophic.

4.4 FACTORS AFFECTING GERMINATION:

The effects of the environment on seed germination is quite complex. A few of the major environmental factors are discussed here.

a. water : Water is the basic requirement for seed germination. It is essential for enzyme activation. Thus, permits breakdown, hydrolysis, translocation and use of reserve food material. However, extreme moisture may inhibit germination.

b. Air(O₂ & CO₂) :Most of the seeds germinate well under normal concentration of gases (20% O₂, 0.03% CO₂ and 80% nitrogen gas). Among them adequate supply of O₂ must be available for oxidative process like breakdown of inhibitors.

Rice seeds can germinate even in the absence of O₂ (anaerobic conditions), although the seedlings are weak and abnormal. However, N₂ gas has no influence.

c. Temperature: The effect of temperature on germination can be expressed in terms of **cardinal temperatures** that are minimum, optimum and maximum temperature at which germination occurs. The optimum temperature may be defined as the temperature at which greatest percentage of germination is recorded within the shortest period of time. Some of the seeds like wheat and barley can tolerate and germinate at minimum temperature of 3 – 5° c. The optimum temperature for most seeds is between 15°C (wheat) to 30° C (rice). Maximum temperatures at which some species can tolerate and germinate is 35° C (groundnut), 40°C (sorghum) and 50°C (cantaloupe). [However, some species germinate at temperatures approaching the freezing point e.g. alpine seeds.]

The above examples provide a clue that seeds differ in their requirement of temperature for germination. The **low temperature pre – treatment** before germination, usually called **stratification**, and high temperature pre – treatment before germination, usually called **high temperature pre – treatment** are to change the macromolecular structure of the seeds which in its original form in some way prevents germination.

d. Light :The greater promotion of light on germination occurs in red region (660nm) followed by an inhibition zone in the far red region (730 nm). Such promotary and inhibitory effects of red and far-red light respectively on germination is mediated by phytochrome. It is referred to as biologically active in pfr form (far red absorbing form) and germination can proceed. Exposure to far – red light (730) reconverts phytochrome to the red absorbing form (pr) and germination is blocked.

e. Soil conditions : Saline conditions inhibit seed germination. High salt concentration prevents imbibition of water by the seed. The same osmotic effect is also observed when the fertilizers are placed in close contact with seeds.
