**Production of Cool Season Vegetable Crops**

**HVSC 0501**

**TOPIC: DETERIORATION AND LONGEVITY OF COOL SEASON VEGETABLE CROP SEEDS**

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**Introduction:**

* Seed deterioration: The process by which seed **lose its vigour** and eventually its viability and die.

**Definition:**

* Seed deterioration is defined as deteriorative changes occurring with time that increase the seed's vulnerability to external challenges and decreases the ability of the seed to survive.
* Seed deterioration is an irreversible degenerative change in the quality of a seed after it has reached its maximum quality level (Abdul baki and Anderson (1972) ).
* Generally, seeds reached its maximum quality level at physiological maturity, and beyond this point of time only degeneration occurs.
* Seed deterioration as a decline in quality, character, vitality, vigour or usefulness of seed (Gove (1965) ) .

**Types of seed deterioration:**

* Field weathering
* Harvest and post harvest deterioration
* Storage

**Field weathering**

* The deterioration of seed quality, vigour and viability, due to high relative humidity and high temperature during the post-maturation and pre-harvest period is referred to as field weathering (Bhatia *et al*., 2010).
* Weathering occurs in the period between the attainment of physiological maturity till harvesting in the field.
* Deterioration caused by weathering is directly related to seed exposure to adverse conditions, so that the physiological quality is depending on the environmental conditions preceding harvesting (Padua *et al*., 2009).
* **Harvest delays** beyond optimum maturity intensify seed deterioration. It not only lowers seed germination, but also increases susceptibility to mechanical damage and disease infection. Timely harvesting avoids prolonged exposure to moisture, and is the best means of avoiding weathering

**Harvest and post-harvest deterioration**

* Seed quality is highly affected by harvesting and handling methods.
* Harvest and post-harvest deterioration comprises threshing, processing machinery, seed collection, handling, transporting and drying.
* **Mechanical damage** is one of the major causes of seed deterioration.
* Very dry seeds are prone to mechanical damage and injuries. Such damage may result in physical damage or fracturing of essential seed parts; broken seed coats permit early entry and easy access for microflora, make the seed vulnerable to fungal attack and reduce storage potential (Shelar, 2008).
* In its severest form, physical seed damage is exhibited by splitting of the cotyledon, shattered and broken seeds. Large seeded varieties are more sensitive to mechanical damage than small seeds.

**Storage**

* Storability of seeds is mainly a genetically regulated character and is influenced by quality of the seed at the time of storage, pre-storage history of seed (environmental factors during pre and post-harvest stages, moisture content of seed or ambient relative humidity, temperature of storage environment, duration of storage and biotic agents (Shelar *et al*., 2008).
* Damage of seed during storage is inevitable.
* The environmental conditions are very difficult to maintain during storage.
* The seed storage environment highly influences the period of seed survival.
* After planting of deteriorate seeds, seedling emergence may be poor and transmission of pathogens to the new crop may occur.
* Lower temperature and humidity result in delayed seed deteriorative process and thereby leads to prolonged viability period (Mohammadi *et al*., 2011).

**Characteristics of seed deterioration**

James c. Delouche's concept regarding the characteristics of seed deterioration as follows :

1. Seed deterioration is an inexorable process:
2. Deterioration in seeds is an irreversible process.
3. Deterioration is at its lowest level at the time of seed maturation.
4. Rate of deterioration varies among the different kinds of seed.
5. Rate of deterioration varies among seed lots of the same kind stored under the same conditions.

**Manifestation of seed deterioration**

* Changes in seed coat colour or embryo or endosperm
* Delay of radicle emergence and seedling growth
* Reduced total germination of seed population
* Increase in the number of abnormal seedlings
* Lower tolerance to adverse storage conditions
* Loss of vigour
* Slower rate of seedling growth and development
* Decreased germination percentage
* Stunting of radicle
* Decreased resistance to environmental stress during germination and early seedling growth
* Reduced yield potential
* The complete loss of germinability and death of the seed

**Changes associated with Deterioration:**

**Morphological Changes:**

• Change in seed coat colour

• Examples: Darkening of seed coat in deteriorating clover, groundnut and soybean seed

• It is due to oxidative reactions in seed coat, which are accelerated under high temperature and high humidity.

**Ultra Structural Changes**

• Mitochondria: It become permanently swollen and loss their natural swelling contracting ability

Decrease in the respiration rate of the seeds.

• Ribosomes: Protein synthesis retarded

• Nucleus: Develop a peculiar lobed condition in maize

•**Endoplasmic reticulum**: Partially aged seeds have short ER Completely degenerates

**Biochemical Changes**

**• Loss of enzyme activity:** The activity of certain enzyme associated with breakdown of food reserves or biosynthesis of new tissue during germination is reduced. Enzymes that reduced are amylase, catalase, glutathione etc.,

• **Reduced respiration:** As seed deteriorate, respiration becomes progressively weaker, and ultimately leads to loss in germination.

**Genetic Changes**

It is of two possibilities

**1.** DNA is somewhat degraded and fails to produce mRNA(transcription fails) that results in no enzyme formation causing a reduction in germination

**2.** DNA functional, formation of functional stored mRNA. During storage, stored mRNA may be degraded. Impaired transcription causing incomplete or faulty enzyme synthesis leads to slower seedling growth

Production of free radicals (unstable molecules that can damage the cells).

**Physiological Changes**

* Delayed germination
* Decreased tolerance to optimal environmental condition with respect to germination
* Reduced seedling growth
* Increase in abnormal seedling

**Factors of Seed deterioration**

**Abiotic factors**

**Effect of Temperature:**

* High temperature hastened the rate of these biochemical processes triggering more rapid deterioration that resulted in rapid losses in seed having high moisture content (Shelar *et al*., 2008).
* Seeds sensitivity to high temperatures is strongly dependent on their water content, loss of viability being quicker with increasing moisture content (Kibinza *et al*., 2006).

Temperature is important because it influences the amount of moisture and also enhances the rate of deteriorative reactions occurring in seeds as temperature increases.

**Effect of moisture content**

* Seeds stored at high moisture content demonstrate **increased respiration, heating, and fungal invasion** resulting in reduced seed vigour and viability.
* After physiological maturity the rate of seed quality loss depends on the degree of unfavorable environmental conditions surrounding the seed.
* Environmental moisture predominantly intermittent or prolonged rainfall, during the post maturation and pre-harvest period, is quite detrimental to seed quality and cause rapid deterioration.

**Effect of oxygen pressure**

* If the oxygen pressure increases, the viability of seed decreases
* Cabbage – 18 Mpa , soybean- 17 Mpa

**Biotic factors**

**Bacteria and fungi**

There are several factors which favour infection fungi and promote their infestation such as **moisture content of seed, relative humidity, temperature**, pre storage infection and storage pest. Mostly storage fungi belongs to Penicillium and Aspergillus.

* Bacteria needs atleast 90 % RH & Fungi needs almost 75% RH for their development
* All storage micro organism completely inactive below 62%

• Some bacteria in which seed act as vector:

Bacterial canker of tomato - *Corynebacterium michiganense,* Bacterial spot of pepper - *Xanthomonas* spp.

**Insects and mites**

• The optimum temperature for insect activity on storage ranges from 28 to 38°c. The temperature below 17 to 20°c are considered unsafe for insect activity.

* No insect activity at seed moisture contents below 8%. Insect activity is common on 15% moisture content.

**Factors associated with seed**

1. **Kind/variety of seed:**
* The seed storability is considerably determined by the kind or variety of seeds.
* Some seeds are naturally short-lived, e.g., onion, soybeans, peanuts, etc., whereas some seeds like tall fescue and annual rye grass appear very similar but differ in storability.
* Genetic make-up of varieties also influences storability.
1. **Genotypic factors**
* Some types of seeds are - inherently long lived; others. are short lived, while others have an intermediate life span owing to their differences on genetic makeup.
1. **Initial seed quality**
* High initial viability of seeds maintains their quality in storage longer than those with less initial viability.
* Vigorous and undeteriorated seeds can store longer than deteriorated seeds. Seeds that have been broken, cracked, or bruised due to handling deteriorate more rapidly in storage than undamaged seeds.
* Cracks in seeds serve as entrance to pathogens causing consequent deterioration. Seeds that have been developed under environmental stress conditions (such as drought, nutrient deficiency and high temperatures) become more susceptible to rapid deterioration.
1. **Provenance**
* Seeds obtained from different sources may show differences in viability and storability. Nevertheless, the seed begins its existence before it harvest and it is expected that seeds harvested in different preharvest condition.
1. **Toxic substances**
* Loss in seed viability is due to the accumulation of toxic metabolites is the is one of the most attractive explanation of seed deterioration
* Bio chemicals suggested to be the cause of loss in seed viability are Indole derivatives and some Phenolics Example: Coumarin, Ferulic acid, Abscisic acid etc.,

**Methods for testing seed deterioration**

* There is no direct method for estimating seed deterioration .
* However, by assessing seed viability, vigour and enzyme activity seed deterioration is measured.

**Methods Involved**

* Germination Test
* Tetrazolium (Tz) Test
* Electrical Conductivity Test
* Vital Colouring Test
* Enzyme Activity Test
* X-ray Photography Ferric Chloride Test
* Fast Green Test

**Prevention of seed deterioration**

* The rate of ageing and deterioration of seeds in a seed lot can be greatly reduced by controlling external factors like temperature, humidity and infestation by diseases and pests.
* Anti-crypto-biotic factors affecting seed viability thereby causing deterioration can be prevented or rate of deterioration is slowed down from influencing the seed lot by improvement of storage conditions.
* Seed stored in dehumidified storage environment at low temperature (-10 °C to - 30°C) or kept in cryo-preservation retains viability and longer shelf-life of undeteriorated seeds.
* Preventive measures taken and treatments against pathogenic infection of seeds in storage. Dormancy act as a physiological switch and turns off the undesirable cell activities and improves the shelf-life of seeds during storage.

**Steps are taken from the stages of seed multiplication up to storage to prevent deterioration**

* Use only approved seeds for multiplication.
* Inspection and approval of field prior to planting.
* Provide adequate and approved isolation distance with a view to prevent natural out crossing or mechanical mixture.
* Rouging of off types before flowering.
* Certification of the seed crop.
* Sampling and sealing of cleaned seed lot.

**Seed treatments to retrieved the viability of partially deteriorated seed**



**Wet treatment**

* It requires hydration to raise seed moisture as high as 25 % to 30% in water alone or in solution of different chemicals followed by drying back to safe limit of seed moisture for dry storage.
* The choice of a particular treatment would depend on the seed material concerned and its initial seed vigour.

**Wet treatment methods:**

**Soaking drying (SD)** Stored seeds are soaked in water or solution of Chemicals & keep in room temperature for 2-6 hrs and stir occasionally. Shade dry followed by sun dry to bring back to original moisture content.

**Chemicals used (10-4to 10-3M)**

Sodium or potassium phosphate, p-hydroxy benzoic acid, Oxalic acid, p- amino benzoic acid, Potassium iodide, Insecticides, Fungicides Uses: effective in low and medium deteriorated non-leguminous crop seeds.

**Dipping Drying(DD)**

1. Seeds dipped in water or solution for only 2-5 min
2. Wet seeds are taken out immediately and kept covered for 2-6 hrs for absorption of water
3. Dry to original moisture content

**Spraying Drying** **(Sp D)**

1. Seeds spread in a thin layer and then water is sprayed on two equal installment (turnover after 1st installment)
2. Cover the seeds using polyethene sheets for 2-3 hrs
3. Dry to original moisture content for storage

**Moisture Equilibrium Drying (MED)**

1. Seeds are placed in thin layers on the trays kept on a raised platform in a closed moisture saturated chamber lined internally with moist blotter paper gives 100% RH at room temperature
2. After 24 hrs taken out the seed and dry back to original moisture content

**Moist Sand Conditioning Drying(MSCD)**

1. Seeds should be thoroughly mixed with pre-moistened sand with water or solution. Moisture content of the sand is 5-10% by adding water or solution
2. It is kept at room temperature for 16-36 hrs
3. Dry back to original moisture.

**Dry seed treatments**

It avoids the use of water and therefore it doesn't requires such drying back to safe limits for storage . It is ideal choice for treatment of large seed stocks.

**Vapour Treatment**

**•** Seeds are exposed to very low concentration of halogens like chlorine, bromine, iodine or alcohols for 16-72 hrs along with chemicals in closed container.

**Dry Permeation Treatment (solvent infusion method)**

* Dry seeds are immersed in organic solvents like acetone, di-chloromethane etc., Which act as quick penetration carriers of desired hormonal and non hormonal chemicals chemical for 2-3 hrs & Followed by evaporation of solvent by air.

**Dry dressing of seeds with chemicals using inert matter**

1. Calcium carbonate , chalk, charcoal, activated clay are first exposed to vapours of halogen or alcohols
2. Carrier is mixed with Seeds (2-5gm /kg seed).

**Seed longevity**

* Seed longevity, **the period over which seed remains viable**, is an important trait not only for plant adaptation to changing environments, but also, for example, for agriculture and conservation of biodiversity.
* Reduction of seed longevity is often associated with oxidation of cellular macromolecules such as nucleic acids, proteins and lipids.
* Seeds possess two main strategies to combat these stressful conditions: **protection and repair**.
* The protective mechanism includes the formation of **glassy cytoplasm** to reduce cellular metabolic activities and the production of antioxidants that prevent accumulation of oxidized macromolecules during seed storage.
* The repair system removes damage accumulated in DNA, RNA and proteins upon seed imbibition through enzymes such as **DNA glycosylase and methionine sulfoxide reductase**.
* In addition to longevity, dormancy is also an important adaptive trait that contributes to seed lifespan.

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