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Concept of seed deterioration, its symptoms, causes and different theories

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Abstract

The Seed deterioration is the very rapid and irreversible process in agriculture to maintain the agriculture scenario and production we have to do control on seed deterioration. Deterioration directly affects the quality and Seed physiology which leads to invasion of fungus and bacteria at high temperature and high humidity. This deterioration affects the metabolic and physiological process of seed which reduce the activity of antioxidant and causes to free radical production which leads to lipid peroxidation. This article focuses on the main aspects of seed deterioration, symptoms, and different theories given by scientist.

Introduction:

Deteriorative changes occurring with time that increase the seed's vulnerability to external challenges and decrease the ability of the seed to survive. These include genetics, mechanical damage, relative humidity and temperature of the storage environment, seed moisture content, presence of microflora, seed maturity, etc. Relative humidity and temperature are the two most important. Relative humidity is important because it directly influences the moisture content of seeds in storage as they come to equilibrium with the amount of gaseous water surrounding them.

Characteristic of seed deterioration:

1. **Seed deterioration- is an inexorable Process**: This means that seed deterioration must be considered as an unalterable fact. We cannot prevent deterioration we can, however, influence or control its rate.

Fig. 1: Showing seed deterioration

2. **Deterioration in seeds is an irreversible process:** In its very basic form this premise simply states that dead seeds can not be brought back to life -or more realistically perhaps, dead portions or areas in seeds cannot be rejuvenated or made whole again. if seed are allowed to deteriorate in

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the field, or are mechanically abused in harvesting, the damage cannot be undone by subsequent good storage, gentle handling or even seed treatment.

3. **Deterioration is at its lowest level at the time of seed maturation:** By seed maturation we mean the point in the developmental history of a seed when it is physiologically and morphologically capable of developing into a highly vigorous seedling. Although it is generally not realized, seeds usually reach maturity long before normal harvest and at relatively high moisture contents - 30 to 45%. Once the peak of maturation is attained, the seeds having reached maximum dry weight, vigor and viability, there is only one direction to go, downhill.
4. **Rate of deterioration varies among the different kinds of seed:** Cotton seed and soybeans have somewhat similar chemical composition - they are both high in oil and proteins with relatively little starch. Yet, cottonseed will store or keep for 2 or even 3 years while soybeans often deteriorate before the first planting season after harvest.
5. **Rate of deterioration varies among seed lots of the same kind and variety stored under the same conditions:** Seed lots of the same kind and variety, of the same chronological age and viability, and which even look alike, are not necessarily of the same quality.

Delouche made an experiment using crimson clover (fodder) and sorghum seed and decided to replicate the work by using two similar lots of each kind. The lots were carefully selected, sized, aspirated, etc. Yet, as they followed the study over a three year period, the most significant thing to emerge was that the two lots of crimson clover and the two lots of sorghum responded very differently. In each case there was a "good' lot that maintained high viability and vigour for a relatively long period of time, and a bad lot that deteriorated rapidly.

The reason can be drawn from this is that seed lots of the same kind and variety, of the same chronological age and viability, and which even look alike, are not necessarily of the same quality.

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
- Reduced yield potential
- loss of germinability and death of the seed

Theories regarding the Seed Deterioration:

- Changes in Protein Structure
- Depletion of Food Reserves
- Development of Fat Acidity
- Enzymatic Activity
- Chromosomal Changes
- Membrane Damage
- Respiration

Changes in Protein Structure:

- Ewart (1908) theorized that seed longevity depends not on available food reserves but on how long the protein molecules, into which protoplasm disintegrates when drying, can recombine into active protoplasm with the absorption of water. According to this reasoning, protein molecules should disintegrate excessively when seeds are dried to very low moisture levels.
- Crocker (1938) suggested that protein coagulation caused loss of viability. Later he (1948) reported that his protein coagulation theory was too general because of the many kinds of protein in embryos and because his studies did not show which protein coagulates with aging.

Depletion of Food Reserves:

- The theory that depletion of food reserves for the embryo causes seeds to die did not persist long because it was soon evident that many dead seeds still contained ample food reserves. Some Zea mays L. seeds, more than 700 years old, found in the Mesa Verde cliff dwellings, appeared sound visually, yet not a single viable seed was ever found among them

Development of Fat Acidity:

- The development of fat acidity in seeds has been shown to accompany death. Germination declined 8 percent and fat acidity increased 14 units when 8- to 9-percent moisture content soybeans were stored for 700 days. With increased seed moisture content, germination dropped rapidly and fat acidity increased sharply (Holman and Carter, 1952)

Enzymatic Activity:

- Attempts have been made to use enzymatic activity as a measure of seed viability. However, only a few of the many enzymes in seeds have been investigated. Early work with enzymes dealt principally with catalase activity. Crocker and Harrington (1918) found catalase activity in dead Johnsongrass and yet reported a relationship with viability

Chromosomal Changes:

- The mutagenic or chromosomal aberration theory is supported further by the fact that extracts from old seeds induce mutations in fresh seeds the mutation rate increases with age.
- Reactions of root and shoot tip in old seeds closely parallel the reactions of the same kind of seeds when treated with X-ray. Apparently mutagens do not develop under good storage conditions

Membrane Damage:

- According to Villiers (1973), the immediate damage rendering aged seeds incapable of germination is extra-nuclear. Free radical damage to membranes and enzyme systems could affect essential metabolic processes when the seeds become imbibed for germination

Respiration:

- The theories for seed deterioration, except possibly fat acidity, are related to respiration. Respiration increases in proportion to the amount of moisture in seeds, but it is very low at moisture contents between 4 and 11 percent (Baily, 1940] Harrington, 1963). Respiration rates up to about 50° C are also directly proportional to temperature

Symptoms of seed deterioration:

Morphological Changes: - Seed coat color often provides an indication of seed deterioration, particularly for legumes. Darkening of the seed coat in deteriorating clover (Vaughan and Delouche 1968), peanut (Marzke et al. 1976), and soybean (Saio et al. 1980) seeds has been reported Such color changes are presumably due to oxidative reactions in the seed coat which are accelerated under conditions of high temperature and relative humidity.

Ultrastructural Changes: - Deteriorated dry seeds have been examined for ultrastructural changes using electron microscopy and two general patterns of coalescence of lipid bodies and plasmalemma withdrawal associated with deterioration have been observed. Coalescence of lipid bodies in the embryo has been found in a broad group of species, including wheat

(Anderson et a1. 1970), peas (Herman and Granett 1972), and pine (Fernandez Gracia de Castro and Martinez-Honduvilla 1984).

Cell Membranes: - One common facet of deteriorating seeds is their inability to retain cellular constituents which leak out during imbibition. This has three important seed quality implications.

- ✓ Many of these cellular constituents are essential for normal, vigorous germination.
- ✓ Some of the exuded compounds are necessary for maintenance of internal osmotic potential which is responsible for normal water uptake and provides the turgor pressure required for radicle protrusion.
- ✓ The external leakage of these substances encourages the growth of pathogenic micro flora.

Loss of Enzyme Activity: - The most sensitive tests for measuring incipient seed deterioration are those that measure activity of certain enzymes associated with breakdown of food reserves or biosynthesis of new tissue during germination. Examples include amylases (Saxena and Maheshwari 1980), proteinases (Nowak and Mierzwinski 1978), cytochrome oxidase (Ching, 1972), and glyceraldehyde phosphate dehydrogenase (Herman et a1. 1976), high levels of dehydrogenases have been found in heat damaged barley seeds (MacLeod 1952)

Reduced Respiration: - Respiration is a composite expression of activity of a large group of enzymes that react together in breaking down food reserves. As seeds deteriorate, respiration becomes progressively weaker, and ultimately leads to loss of germination. However, prior to loss of germ inability, the respiration level during the early stages of germination has been correlated with subsequent seedling vigor (Woodstock and Feeley 1965).

Increases in Seed Leachates: - A frequently observed symptom of deteriorated seeds is their increased leachate content when soaked in water. The degree of deterioration is associated with the concentration of seed exudates that may be found in the steep solution. These exudates are a reflection of the amount of membrane degradation that has occurred. The leachate concentration has been measured by electrical conductance methods (Hibbard and Miller 1928), and also by determining the soluble sugar content of the leachate (Abdul-Baki and Anderson 1970).

Increase in Free Fatty Acid Content: - The hydrolysis of phospholipids leads to the release of glycerol and fatty acids, and this

reaction accelerates with increasing seed moisture content (Harrington 1973). The continual accumulation of free fatty acids culminates in a reduction in cellular pH and is detrimental to normal cellular metabolism (Earnshaw *et a1*., 1970).

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