SEED EQUILIBRIUM MOISTURE RELATIONSHIPS

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- Water exists as solid (ice), liquid or vapor

- At the temperature at which seeds are stored in Africa, only liquid and vapor phases of water are important

- If liquid water is introduced into an enclosed vacuum space at constant temperature, evaporation takes place until equilibrium vapour pressure is reached.

- Let us say at temperature To, equilibrium vapour pressure is Po.

- If the water is in an air space or is in contact with air at temperature To, the water evaporates into the air until the partial pressure of water vapour is Po; the equilibrium vapour pressure at temperature To.

- The equilibrium vapour pressure increases with increase of temperature.
- Seeds contain varying quantities of water. If instead of water we introduce seeds into a vacuum space or an air space, the equilibrium vapour pressure developed at temperature To is Pe where Pe < Po.
- Pe depends on the temperature, the nature of the seeds and the seed moisture content.

- We define a parameter water activity (air) as follows:
- Aw = Pe/Po
- At a given temperature, aw depends on the nature of the seed and its moisture content
- Water activity of a seed can be interpreted as availability of water to microorganisms.
- It is 1 when the water is completely available and O when is completely unavailable, i.e. it varies between 0 and 1.

- A minimum value of water activity is required for spoilage microorganisms to grow on stored seed.
- The minimum value of water activity for moulds is 0.70 – 0.90.
- For cereal seed, this corresponds to a moisture content of 14.0 – 20% while for peanuts it is 8.5 -15%
- Each seed has a specific relationship between moisture content and water activity.
- In all cases water activity increases with increase in moisture content, and vice versa.

- Seed must therefore be dried and stored at a moisture content that corresponds to a water activity that does not exceed the minimum required for spoilage by microorganisms.
- Seed absorb or lose moisture depending upon the relative humidity of the surrounding air.
- If the relative humidity (decimal) is less than the water activity it loses water through evaporation and if it is greater than the water activity it absorbs water vapour from the air and its moisture content increases.

•Seeds lose or gain moisture to or from the surrounding atmosphere until their moisture content ((MC) reaches a point of equilibrium with the relative humidity and temperature of the surrounding air. The final moisture content reached is the equilibrium moisture content (EMC).

•EMC decreases with increasing temperature and constant RH (even though absolute air humidity increases with temperature at the same RH).

•EMC is always higher on desorption than on adsorption

AERATION AND TEMPERATURE CONTROL

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Aeration system and Technology

- Seed aeration: process of moving air at ambient temperature through stored seed in order to control the temperature to the desired level.
- An aeration system includes a fan, an air supply duct, aeration ducts (or a perforated floor), and a controller.
- Aeration ducts are less expensive than perforated floor but cause uneven distribution of air through the seed.

Aeration system and Technology…

- In small storage systems, aeration can be done by natural air circulation; allowing the wind to blow through the stored seed.
- In addition to temperature control, stored seed aeration also minimizes moisture migration within the grain bulk.

Temperature of stored seed grains

- The temperature of the harvested grain establishes the initial temperatures of stored seed.
- These initial temperatures can be equal to or considerably higher than the atmospheric air temperature.
- In one case the temperature of freshly harvested seed was found to be 30^{o}C when the atmospheric temperature averaged 23^{o}C.
- Such high initial temperatures encourage rapid deterioration of the stored seed if cooling is not rapid. Changes in diurnal temperature affect seed temperatures in bins.

- Solar radiation incident on the bin wall causes its temperature to rise to a value much higher than that of the atmospheric air.
- Cases have been cited where when the atmospheric air temperature was 28^{o}C, the temperatures of bin surfaces in contact with the stored seed varied from 37^{o}C to 56^{o}C.
- This varied depending on the material of construction and colour of the bin wall.

- Seasonal changes in atmospheric temperature cause changes in the temperature of stored seed.
- Weather conditions are in fact the most important factors affecting storage seed temperatures.
- Changes in atmospheric air temperature and solar radiation have less effect on the temperatures near the centers of large bins than of small bins.
- However, heat in freshly harvested seed and heat generated in deteriorating seed are dissipated more rapidly from small bins than from large bins,
- This is because the distance form the centre of the bin to the wall is less in small bins than in large bins.

- As a result, temperatures will rise less above atmospheric air temperature and seed deterioration will be less in small bins than in large bins.
- Insulating a bin has a similar effect on the heat transfer in and out of the bin as increasing the bin size.
- Insulation reduces the temperature gradients throughout the seed bulk and therefore may reduce moisture migration within the bin.

- The rate of heat transfer into or out of seed stored in underground bins is slow and is similar to that in large bins and insulated bins.
- This is because soil is a good thermal insulator.
- If cold seed is stored in underground bins, it will normally remain at a low temperature if the soil temperature remains low.
- But in underground bins, as in large above-ground bins, heat in freshly harvested seed and heat generated in deteriorating seed is dissipated very slowly.
- Consequently, seed deterioration can occur very rapidly if the initial temperature of the seed is high or if the temperature of the seed begins to rise.

Moisture Migration

- Moisture may migrate from one part of the stored grain to another.
- Moisture migration is caused by differences in temperature in different parts of the bulk.
- Moisture in the vapor phase moves by diffusion along the vapor-pressure gradient caused by a temperature gradient in material of fairly uniform moisture content.
- Convection currents also contribute to moisture migration. When saturated air moves from a warm to a cooler region condensation of some water vapour occurs since the water carrying capacity of the air is reduced. The condensed water is absorbed by the grain in the cool region whose water activity thus increases. Deterioration may thus occur in stored grain even if it is stored at a safe and uniform moisture content. Diffusion is said to be the dominant mechanism of moisture transfer, assisted by convection currents.

THANK YOU