Document Title: Description, An, Seed Aw	Part # and Rev. 13437-00
	Release Date:

Rev.	Description	Revision By	Date

Production Filename: 13437 (In Product Library)

Path to Working Files: DecaDoc\Application Notes\Master

Dimensions: 8.5 inch wide, 11 inch tall

Material: Paper, 92 Bright White or better, 75g/m² or heavier

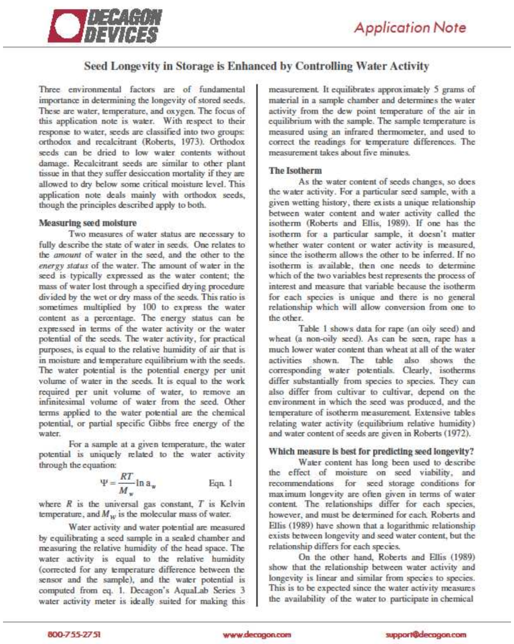
Colors: Color Print on White

Printer: HP Color LaserJet 8550-PS

Finish: None

Adhesive: None

Special Notes: Illustrations are Ref Only ** Not to Scale ** (Shown page 1 of 2)



DECAGON DEVICES

Application Note

Seed Longevity in Storage is Enhanced by Controlling Water Activity

Three environmental factors are of fundamental importance in determining the longevity of stored seeds. These are water, temperature, and oxygen. The focus of this application note is water. With respect to their response to water, seeds are classified into two groups: orthodox and recalcitrant (Roberts, 1973). Orthodox seeds can be dried to low water contents without damage. Recalcitrant seeds are similar to other plant tissue in that they suffer desiccation mortality if they are allowed to dry below some critical moisture level. This application note deals mainly with orthodox seeds, though the principles described apply to both.

Measuring seed moisture

Two measures of water status are necessary to fully describe the state of water in seeds. One relates to the *amount* of water in the seed, and the other to the *energy status* of the water. The amount of water in the seed is typically expressed as the water content; the mass of water lost through a specified drying procedure divided by the wet or dry mass of the seeds. This ratio is sometimes multiplied by 100 to express the water content as a percentage. The energy status can be expressed in terms of the water activity or the water potential of the seeds. The water activity, for practical purposes, is equal to the relative humidity of air that is in moisture and temperature equilibrium with the seeds. The water potential is the potential energy per unit volume of water in the seeds. It is equal to the work required per unit volume of water, to remove an infinitesimal volume of water from the seed. Other terms applied to the water potential are the chemical potential, or partial specific Gibbs free energy of the water.

For a sample at a given temperature, the water potential is uniquely related to the water activity through the equation:

$$\Psi = \frac{RT}{M_w} \ln a_w \qquad \text{Eqn. 1}$$

where R is the universal gas constant, T is Kelvin temperature, and M_W is the molecular mass of water.

Water activity and water potential are measured by equilibrating a seed sample in a sealed chamber and measuring the relative humidity of the head space. The water activity is equal to the relative humidity (corrected for any temperature difference between the sensor and the sample), and the water potential is computed from eq. 1. Decagon's AquaLab Series 3 water activity meter is ideally suited for making this measurement. It equilibrates approximately 5 grams of material in a sample chamber and determines the water activity from the dew point temperature of the air in equilibrium with the sample. The sample temperature is measured using an infrared thermometer, and used to correct the readings for temperature differences. The measurement takes about five minutes.

The Isotherm

As the water content of seeds changes, so does the water activity. For a particular seed sample, with a given wetting history, there exists a unique relationship between water content and water activity called the isotherm (Roberts and Ellis, 1989). If one has the isotherm for a particular sample, it doesn't matter whether water content or water activity is measured, since the isotherm allows the other to be inferred. If no isotherm is available, then one needs to determine which of the two variables best represents the process of interest and measure that variable because the isotherm for each species is unique and there is no general relationship which will allow conversion from one to the other.

Table 1 shows data for rape (an oily seed) and wheat (a non-oily seed). As can be seen, rape has a much lower water content than wheat at all of the water activities shown. The table also shows the corresponding water potentials. Clearly, isotherms differ substantially from species to species. They can also differ from cultivar to cultivar, depend on the environment in which the seed was produced, and the temperature of isotherm measurement. Extensive tables relating water activity (equilibrium relative humidity) and water content of seeds are given in Roberts (1972).

Which measure is best for predicting seed longevity?

Water content has long been used to describe the effect of moisture on seed viability, and recommendations for seed storage conditions for maximum longevity are often given in terms of water content. The relationships differ for each species, however, and must be determined for each. Roberts and Ellis (1989) have shown that a logarithmic relationship exists between longevity and seed water content, but the relationship differs for each species.

On the other hand, Roberts and Ellis (1989) show that the relationship between water activity and longevity is linear and similar from species to species. This is to be expected since the water activity measures the availability of the water to participate in chemical

800-755-2751 www.decagon.com support@decagon.com