The Physiological Nature of Snap Bean Semi-Hard Seeds

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Snap bean semi-hard seeds (SHS) have been defined as seeds which do not fully imbibe water during the first 24 hours, when their initial moisture content is 8% or less (1). However, if initial moisture content is greater than 10%, the seeds imbibe readily. This semi-permeable nature of water uptake is solely dependent on the initial seed moisture content, which in turn, is determined by the humidity of the seed storage atmosphere (2). SHS have excellent seed quality resulting in vigorous germination and seedling growth (1). SHS also avoid imbibitional chilling injury attributed to slow hydration rates (2). Compared to two commercial cultivars, SHS at low (6%) and high (12%) moisture content showed improved field seedling emergence when sown in cold soil. Heritability and seedling establishment of SHS have been studied. The reversibility of SHS due to seed moisture content has been proved. However, little is known about the physiological characteristics of SHS. The purpose of this research was to determine where and how water first enters the seed. The anatomical and chemical properties of the seed coat in regions were investigated to determine the reason(s) for the water barrier in SHS.

Water always follows the same pattern when entering the seed testa of SHS during imbibition: it enters the region of the raphe and the chalazal part of the testa (R-CT), migrates circumferentially within the middle of seed coat, leaving the lateral surfaces the last to be fully imbibed (Fig. 1). The R-CT region was found to be the main site of primary uptake of either water vapor or liquid water by SHS. The hilum, micropylar and strophiolar regions play only a minor role in water uptake.

A decrease in seed moisture content from 12% to 6% was accompanied by a 7.8% decrease in seed volume.

Significant differences in length and width were found between cells of the palisade layer in the R-CT region. In both the proximal and distal parts of the raphe, a change in seed moisture content from 6 to 12% was accompanied by a decrease in cell length and an increase in cell width, while most cells of the CT showed an increase in length and a decrease in width. Raphe palisade cells in SHS therefore become shorter and wider as moisture content changes from 6 to 12%, whereas the opposite is generally true for the CT. The palisade cell layer has been shown to be of importance in seed coat impermeability in leguminous species (3).

Compared to a typical cultivar (non-SHS Bush Blue Lake 47), SHS had more total phenols in the osteosclereid cells subjacent to the palisade layer, and more pectic substances in palisade cells of the CT. The presence of

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these compounds could account for the impermeable nature of SHS. Semi-hardening of bean seeds opparently results mainly from reversible physical changes in palisade cell size in the R-CT region. Seeds are able to imbibe at high moisture content because the palisade cells have stretched, which allows water uptake. Seeds are impermeable at low moisture content because the palisade cells contract and form a physical barrier for water movement.

Refrences

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Caption

Fig. 1. The imbibition pattern of semi-hard seeds over time. A) 22 min., seed from the hilum (H) side. Water enters into the raphe and chalazal region of the testa. S, strophiole. B) 45 min., seed opposite hilum, i.e. dorsal ridge (DOR). Water migrates along the midline around the chalazal end, then along DOR. C) 90 min., lateral face of seed. Water moves from the R-CT region bidirectionely around the chalazal lobe (CL) and lobe near embryonic axis (AL), until all the midline tissues are imbibed. D) 150 min., lateral face of seed. Water is absorbed leaving by the lateral faces themselves. Arrows showed direction of the water uptake. Scale = 1.0 mm.