Abstract No. prun11

Spatial Distribution of Iron in Common Bean Seed

L. Prunty, J. Bell, J. Moraghan (North Dakota St. U.), and T. Lanzirotti (CARS/U. Chicago)

Beamline(s): X26A

Introduction: Plant seed consists of maternal seed coat tissue and filial embryonic tissue. Little is known about distribution of elements within these tissues for common bean (*Phaseolus vulgaris L.*) seed. Recently, the distribution of Fe between the seed coat and embryo in *P. vulgaris* was found to be a heritable trait (Moraghan and Grafton, 2001). However, current research has not shown how Fe and other elements are distributed within the maternal and filial tissues of diverse bean genotypes. Synchrotron x-ray techniques were investigated for this type of analysis.

Methods and Materials: The small diameter of the beam on beamline X26A (approximately 15 microns) allowed us to determine micronutrient (Fe, Mn, Ca, etc.) contents in very small areas of interest within bean seed. We used the beam on X26A to determine micronutrient distributions within cross sections of common bean seed, including both the seed coat and embryo. Three cultivars of common bean seed were studied: Voyager (a navy bean), UI911 and T39 (black beans). Seeds used were from a greenhouse study of the effects of lime and Fe additions on Fe accumulation among common bean cultivars. 1 mm thick sections cut perpendicular to the long axis of the seeds were mounted on kapton tape using 35 mm photographic slide mounts. We scanned various portions of the bean sections in several directions, with various step sizes; but the majority of the scans were made perpendicular to cotyledon splits, across the maximum diameter of the sections, at 100 micron steps. Elemental abundance was calculated from energy dispersive x-ray fluorescence spectra (collected using a Canberra Si(Li) detector). For these analyses a monochromatic x-ray beam was used, tuned to ~16 keV using a Si(111) channel cut monochromator. This monochromatic x-ray beam (collimated to 300 microns diameter) was then focused to ~15 microns using X26A's Kirckpatrick-Baez microfocussing mirror system. We specified regions of interest in the florescence spectrum for K, Ca, Cr, Mn, Fe, Cu, Zn, Br, Rb, and Sr, although we were initially primarily interested in Fe. Raw data were corrected for beam strength, and the resulting data were then interpreted to reflect planer, cylindrical, and spherical seed geometries.

Results: Iron data from cylindrical and spherical models were in reasonable agreement with chemical analyses (Moraghan et. al, 2001). Chemical analyses show the highest seed coat Fe in UI911, and the lowest in Voyager, with T39 intermediate; and embryo Fe highest in Voyager and lowest in UI911 with T39 again intermediate. Our x-ray data indicated a very general trend in Fe content among cultivars along embryo cross-sections. All three cultivars had highest Fe near the outer edge of the embryo with Fe progressively decreasing toward the center of the embryo. Our preliminary analysis indicates that Fe decreased at a faster rate toward the center of UI911 embryos, while Voyager Fe decreased more slowly toward the center, with T39 intermediate.

Conclusions: We believe further research is warranted to use the synchrotron x-ray technique to map micronutrient distributions within common bean embryos and seed coats and to more closely compare results to chemical analysis. Additional data are needed to distinguish between experimental error (variability) and true differences due to genetic and other factors. This would increase our limited body of knowledge of micronutrient distributions in common bean seeds.

References:

J.T. Moraghan and K. Grafton, "Distribution of selected elements between the seed coat and embryo of two black bean cultivars," J. Plant Nutr., (accepted for publication), 2001.

J.T. Moraghan, J. Padilla, J.D. Etchevers, K. Grafton, and J.A. Acosta-Gallegos, "Soil and genetic factors influencing iron accumulation in common bean seed," (in review), 2001.