

Agriculture & Synchrotron Science

Being in the heart of the Prairies, there is a large interest in agricultural applications of the Canadian Light Source. There are many ways synchrotron science can be involved in agricultural research from analyzing soil, contributing to the development of more resistant crops, researching cures for diseases both in crops and animals, researching methods to detoxify the environment, to developing new products. With such a diverse area of research, there are several ways the synchrotron can be utilized.

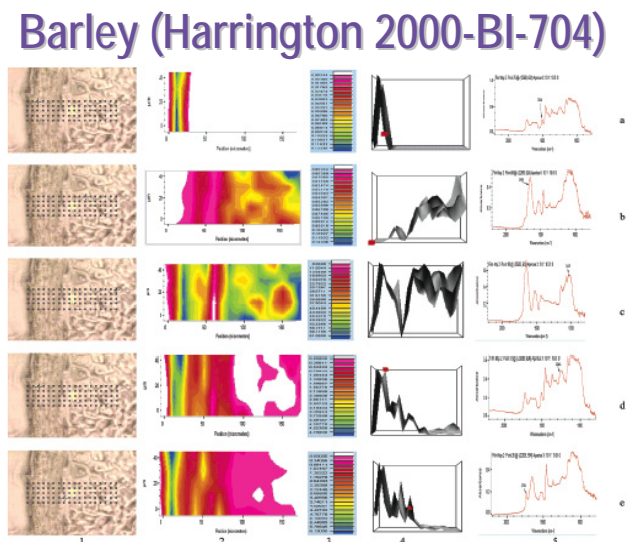
Learning more about plant proteins may allow researchers to develop **crops that are more resistant to environmental stresses** like drought, cold and salt. “It’s the proteins in plant membranes that perceive stresses like cold, and then decide how to react to protect the plant,” University of Saskatchewan Researcher Michelle Loewen says. Her research involves use of both X-ray Crystallography techniques at the synchrotron and traditional lab techniques. The results of her research could have far reaching implications. Crops with frost and cold resistance could mean longer crop seasons and greater yields. Breeding plants that can resist salt means existing unusable soil may become viable, increasing the available land for agricultural use. These advancements could make changes worldwide.



By understanding how the proteins in the plants perceive stresses and how they react they can develop crops with different traits. Analyzing the structure of these proteins with synchrotron crystallography will speed up the results tremendously when compared to traditional methods.

http://www.lightsource.ca/brochures/pdf/michele_final.pdf

Synchrotrons can be used to map where different nutrients are contained in seeds, which could lead to better quality feed. Another use of synchrotron research is a better understanding of substances in seeds such as lignan, which is not useful for feed. Knowing where lignan is in barley seeds could help researchers develop a feed that is easier for animals to digest. University of Saskatchewan researcher Colleen Christensen analyzed barley seeds using InfraRed (IR) light. The spectrum (image to the extreme right) proves the presence of this substance and the maps (colour and 3D

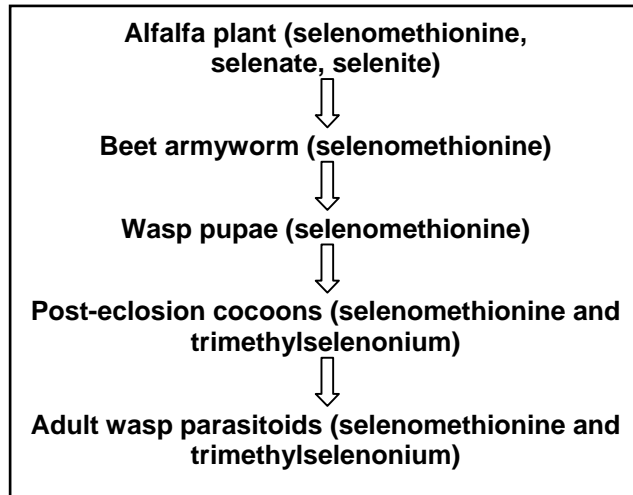


Yu et al. 2003. *J. Agric. Food Chem.* 51: 6062-6067

intensity) show that lignan is located close to the surface of the seed. If a method of striping the outer edge (a few microns deep) of the seed was developed, a barley feed could be produced that has removed a significant contributor to waste material.

<http://pubs.acs.org/cgi-bin/article.cgi/jafcau/2004/52/i06/pdf/jf035065a.pdf>

Phytoremediation is an emerging field that uses plants to clean up contaminated soils. Synchrotron light can be used to determine how elements change as they go through the food chain. Selenium poisoning is a global contamination problem release through a variety of industrial and agricultural activities including mining, combustion of fossil fuels, fertilization, and the production of glass. Synchrotron X-ray absorption spectroscopy conducted by University of Saskatchewan researchers Ingrid Pickering, graham George, and Helen Nichol tracked the changes in the speciation of the selenium as alfalfa plants accumulated the toxic selenium from the soil. Each level of the food chain transforms selenium into a less toxic form. Selenium is an essential micronutrient, but at higher levels and in certain states, it can be toxic. Livestock may be poisoned by selenium rich plants.



The beet army worm, an insect commonly found with alfalfa plants, consumed the plant and was subsequently consumed by a wasp pupae that continued through its life cycle. The researchers were able to track the changes in speciation of the selenium at each stage showing it to be in an organic state by the end of the life of the wasp. The selenium is in a less toxic form after each step, and this proves that the selenium is being detoxified. While not a solution to selenium contamination (beet army worms are considered an agricultural pest), the

synchrotron provided valuable information for the research program. Evidence available from synchrotron research contributes to understanding the role that plants and insects play in the detoxifying process.

http://announcements.usask.ca/news/archive/2004/07/u_of_s_research_18.html

<http://pubs.acs.org/cgi-bin/article.cgi/esthag/2004/38/i13/pdf/es049941s.pdf>

Picture courtesy of Vicherman, D., Trumble, J., George, G., Pickering, I., and Nichol, H.