Holistic approach to advance onion postharvest handling efficiency and sustainability

Changying Li[1], Howard Schwartz[2], Krishna Mohan[3], Joseph Molnar[4], Kimberly Morgan[5], Ron Gitaitis[1], Gary Hawkins[1], Dan MacLean[1], Robert Shewfelt[1], Chi Thai[1], William Tollner[1]

[1]University of Georgia, [2]Colorado State University, [3]University of Idaho, [4]Auburn University, [5]Mississippi State University

Challenges for onion postharvest industry

Onion is the third-largest fresh vegetable crop in the U.S. As a critical link between the farm and the consumer, postharvest handling plays a vital role in the onion industry. The current sorting and storage system is largely based on human inspection and unable to confront challenges like the growing demand for high-quality products from consumers, looming shortages in labor, and significant losses in storage due to lack of detection tools and management strategies. Discarded onions from the packinghouse or storage can lead to environmental pollution and increased disease pressure. The overarching goal of this SCRI Project is to advance the efficiency and sustainability of the onion postharvest handling through a systems approach and trans-disciplinary research and extension effort.

Multimodal sensing for onion quality and diseases

• A multimodal sensing platform will be developed to integrate X-ray and hyperspectral imaging technologies. The X-ray imaging will provide internal quality information and the hyperspectral imaging will detect surface defects and quality properties (such as dry matter content). This multimodal sensing system will potentially greatly enhance the efficiency and versatility of the current onion sorting system.
• Sensory and consumer acceptance evaluation will be conducted to evaluate the pungency, bitterness, and sweetness of onions before and after X-ray inspection.

Area leaders: Changying Li, Chi Thai, Bill Tollner, Robert Shewfelt, University of Georgia
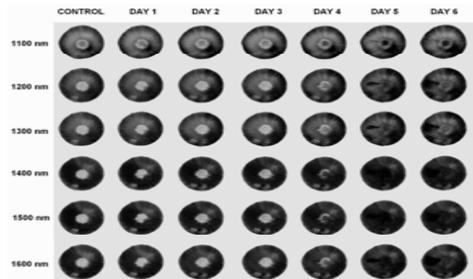
Progress:
• Developed a hyperspectral imaging system based on liquid crystal tunable filter (LCTF)
• LabVIEW software to control InGaAs camera and LCTF filter.
• Large aperture spectrometry system for consumer taste prediction

Schematic of LCTF system
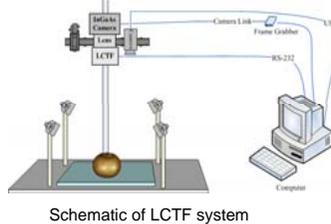
Sensory evaluation

Large aperture NIR spectrometry setup

Mosaic images of one onion with sour skin infection observed from 0-6 days

Disease detection in storage

• Evaluate and design a gas sensor to specifically target onion diseases, Botrytis and sour skin.
• Preliminary lab test will be conducted to identify and classify onion diseases using a conducting polymer electronic nose and a surface acoustic wave sensor (zNose).
• Low-cost gas sensor array and pattern recognition software will be developed and deployed in onion storage rooms.
• Determine the location and strength of rot onions in a storage room by utilizing the concentration field obtained from multiple gas sensor arrays.
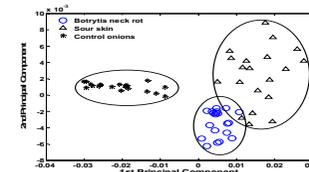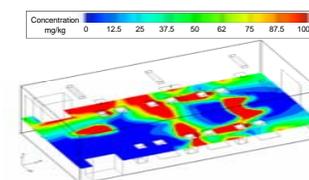

Onions in storage

Area leaders: Changying Li, University of Georgia, Xianting Li, Hao Cai, Tsinghua University; Norman Schmidt, Georgia Southern State University.

Progress:
• Commerical gas sensor array was evaluated for onion Botrytis and sours skin detection.
• Simulation model was developed to trace rot onions.

Gas sensor response to diseased onions after 4 days inoculation (Li et al, 2009)

CFD simulation of rot onion odor concentration in storage after 90 seconds

Disease control and management strategies

Effective disease control and management strategies will be developed and demonstrated in this project to prevent onions from becoming diseased in the field, to isolate infected onions or stop further infection to other wholesome onions. We will evaluate several postharvest disease treatment practices (such as sulfur dioxide, ozone, field curing, and chlorine dioxide), as well as pre-harvest IPM field management strategies (such as crop rotation, resistant variety selection, apply bactericides at late vegetative growth, and cure onion tops well in the field).

Area leaders: Ron Gitaitis, Dan MacLean, University of Georgia, Howard Schwartz, Colorado State University, Krishna Mohan, University of Idaho; Claudia Nischwitz, Utah State University.

Progress:
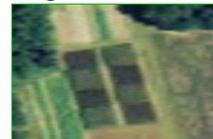
Crop rotation

Curing

Drench treatment

Waste stream management

The goal is to utilize cull onions as feedstocks of the anaerobic digester for biogas production, not only to reduce environmental pollution and disease propagation, but also to generate biogas to power the onion postharvest handling facilities, such as the folk lift.
• In the year 3, a pilot-scale AD system (V=3000 L) will be developed on UGA campus and tested at a local packing shed.
• PIs will also review and define feedstocks that can be used for anaerobic digestion and composting processes to better promote community development in rural areas.

Area leaders: Gary Hawkins, David Langston, University of Georgia, Christy Hoepting, Cornell University.

Progress:
• A laboratory-scale anaerobic digester (V=45 L) was designed to decompose discarded onions.

Schematic of an anaerobic digester

Lab scale anaerobic digester

Socioeconomic analysis

• The focused group interviews and online surveys will address the constraints and costs of developed technologies and management strategies.
• PIs will engage stakeholders to identify technology barriers, quantify risk perceptions, clarify paths for technology development and adoption, and to determine production risk minimization levels.

Area leaders: Kim Morgan, Mississippi State University, Joseph Molnar, Auburn University.

Progress:
• PIs are making surveys and interviews in five states

Outreach and extension

• Effective and trusted Cooperative Extension paths of technology transfer and implementation such as on-farm and storage shed visits, local, regional and national grower meetings, field days, and an array of print and electronic references are in place in the participating states.
• Graduate students training.
• Develop project website.

Area leaders: Changying Li, Howard Schwartz, Ron Gitaitis

Progress: launched project website: http://www.alliumnet.com/PostHarvestHandling.html