Combating Onion Bacterial Diseases with Pathogenomics Tools and Enhanced Management Strategies:
Research Objectives and Progress Towards Reducing Crop Losses

1University of California Cooperative Extension, 2University of Georgia, 3University of Pretoria, 4Washington State University, 5Cornell Cooperative Extension, 6Colorado State University, 7University of Idaho, 8Bejo Zaden B.V., 9Pennsylvania State University, 10Texas A&M University, 11Utah State University, 12Oregon State University

About the Project
*Stop the Rot* is a USDA NIFA SRI-funded project (2019-2023) investigating the host, pathogens, and environmental factors influencing bacterial diseases of onion. The project has two primary research objectives:
1. Survey onion growing regions across the USA and compare the genomics of onion bacterial pathogens in different regions of production; Through research trials, identify onion production practices, environmental factors, and inoculum sources that impact bacterial diseases, and use this knowledge to develop effective, economically viable disease management strategies.

Regional Surveys
To provide regional characterization of onion bacterial pathogens, project team members from 11 states in the USA surveyed symptomatic onion foliage and bulbs in 2020 and 2021. From these surveys, a total of 95 bacterial genera were isolated from onion foliage and bulbs in participating states. The four most prevalent genera were: Pantoea (700 strains to date), Pseudomonas (353 strains), Burkholderia (271 strains) and Enterobacter (224 strains). The distribution and pathogenicity of isolates of these genera varied across onion production regions, as shown in Fig. 1 below for 2020.

Pathogenomics
Accurate pathogen diagnosis precedes effective disease management strategies targeted to the pathogen(s). Our initial focus is on Pantoea agglomerans, a ubiquitous bacterium of national concern in the USA. Identifying genes in Pantoea spp. associated with pathogenicity to onion will facilitate developing DNA-based diagnostic tools to quickly and accurately distinguish strains of Pantoea that are virulent on onion.

Identifying virulence mechanisms of pathogens
The red scale necrosis (RSN) assay for pathogenicity to onion of P. agglomerans strains correlated significantly with the presence of the HVir gene cluster. The HVir cluster encodes a biosynthetic pathway for the phosphate phytotoxic factor phytotoxin and is a critical necrosis-inducing, onion pathogenicity factor for P. ananatis. The HVir gene cluster also has been identified in strains of P. agglomerans. Loss of the pathogenic RSN phenotype in six strains of P. ananatis was linked to specific nucleotide polymorphisms (SNPs) induced in various genes in the HVir cluster.

Rapid diagnostic tools
We are designing species-specific real-time PCR and loop mediated isothermal amplification (LAMP) assays for key bacterial pathogens of onion. The assays are based on genetic markers for pathogenicity to onion as well as bacterial taxonomic markers. The assays will be tested on samples from onion crops in 2022.

National Onion Bacterial Strain Collection
The NBSC is intended to represent the diversity of onion bacterial pathogens across the USA and will serve as a repository of characterized onion bacterial strains available publicly to the research community. The NBSC currently contains 775 bacterial strains representing 8 genera, with more strains to be added.

Irrigation
Timing of irrigation cut-off affects bulb rot: In a Georgia trial in 2021, withholding irrigation (TopAir) reduced bacterial bulb rot by 97% compared to sprinkler irrigation. Mechanical vs. manual harvest: In a Georgia trial in 2020, mechanical harvest resulted in significantly less bacterial bulb rot compared to manual harvest. Similer results were observed in a 2021 trial in Georgia. Early results:
- Mechanical harvest resulted in significantly less bulb rot compared to manual harvesting. Similar results were observed in 2021 trials in Georgia.
- Reducing neck length at harvest: In a Georgia trial in 2021, reducing the neck length from 3 inches to 1.5 inches resulted in 70% reduction in losses to bacterial bulb rot. Similar results were observed in 2020. Bulbs were cured before topping. Internal rot was associated with Pantoea spp., and with Enterobacter spp. and Pectobacterium spp.
- Timing of topping bulbs: In a 2021 Washington trial, topping the tops of plants at 50% ‘tops down’ reduced bacterial bulb rot by 27% compared to topping at ≥50% ‘tops down’.

Foliar applications of bactericides & plant defense inducers
Efficacy of foliar bactericide applications varied greatly between production regions in the southeastern USA and summer production in western and northern states, possibly reflecting regional differences in the spectrum and timing of infection of onion plants by bacterial pathogens. Copper-based products had limited efficacy in western and northern regions of the USA, where most bacterial infections occur in the necks rather than the leaves.

Economic Assessments
Economic returns of selected disease management recommendations, based on field trial results, are being calculated for different production regions to help stakeholders understand the economic viability of management options.

Early results:
- Economic losses to onion rot are a significant concern for the onion industry.
- Stakeholders agree there is no single highly effective strategy for reducing losses, but irrigation management and post-harvest curing are perceived as effective options.
- Even with escalating chemical prices, a positive economic return was found for a high input bactericide & plant defense inducer treatment of onion bulbs.

Post-harvest disinfectant treatment of onion bulbs
In 2020 and 2021 trials, application of ozone or disinfectant products containing peracetic acid to onion bulbs after harvest did not reduce losses to bacterial bulb rots in storage.

Enhanced management strategies for combating bacterial diseases
Field trials across multiple states are focused on the impacts of a range of management practices on onion bacterial diseases. The trials are evaluating production practices and products to address stakeholder priorities and concerns about bacterial diseases of onion. For detailed results, see https://alliumnet.com/stop-the-rot-publications-and-resources.

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