Struggles in Guatemalan agriculture and the role of plant pathology

Farming communities worldwide suffer crop loss from drought, nutrient-poor soils, pests, and plant pathogens. Of these, plant diseases caused by bacteria, viruses, fungi, and nematodes contribute to the majority of cash and subsistence crop losses. One significant bacterial plant pathogen, *Ralstonia solanacearum*, causes the plant disease bacterial wilt on a wide range of cash and subsistence crops. *R. solanacearum* remains one of the most destructive pathogens in Latin America because there is little control effective in eradicating this soil-borne disease-causing agent. In Guatemala specifically, bacterial wilt results in a significant crop loss for tomato, banana, and potato farmers due to its persistence in water systems and soils. Plant disease epidemics, specifically from bacterial wilt, destroy livelihoods often resulting in social and political unrest. Plant pathologists play critical roles in agriculture through outreach and research by resolving disease epidemics to help growers produce healthy crops.

Small community farmers hold a major role in the Guatemalan economy. Guatemala’s fertile land holds many promises of financial success in agriculture. However, there is a major roadblock that halts this potential: even though small farms comprise the majority of the rural population, they are left without any governmental support. In the United States, individual states and the USDA maintain U.S. agricultural productivity through different extension programs and research; Guatemalan growers receive no such internal governmental aid or technical support.

The Department of Agronomy at La Universidad de San Carlos de Guatemala (USAC) volunteers considerable time to ameliorate Guatemalan agriculture and fill the need of extension assistance. Professors Luis Mejía and Amilcar Sanchez of USAC facilitate outreach and research programs to relieve plant disease burdens throughout Guatemala. Additionally, Professors Caitilyn Allen and Douglas Maxwell of UW-Madison lend their expertise in plant pathology and collaborate with the USAC faculty to contribute to Guatemalan human welfare in agriculture. Through the LACIS Internship Grant, I paired with professors at USAC and UW-Madison to carry out an internship, during which I contributed to extension aid for farmers throughout Guatemala, performed some basic biological research, and assisted with a plant-breeding program to develop disease-resistant tomatoes.

Auspicious agricultural aid at USAC

As previously mentioned, the plant pathogenic bacterium *R. solanacearum* wipes out a wide range of cash and subsistence crops such as tomatoes, potatoes, peppers, and bananas. *R. solanacearum* taints soils and water systems and is practically impossible to remove once the soil has been contaminated. Many farmers switch to planting less-profitable crops not susceptible to bacterial wilt, such as corn, because they can no longer grow valuable tomato or pepper crops on their land. With limited options to treat bacterial wilt, researchers at USAC have searched for control measures through outreach education and breeding tomatoes for resistance. I was able to combine my heterogeneous specializations of science and Spanish to help with their various programs.
Much of my internship was carried out in the field at various farms countrywide to understand the basic epidemiology and ecology of bacterial wilt. Epidemiology and ecology of pathogens give useful insight in disease management. Prof. Sanchez and I gathered samples from water systems throughout the Lake Atitlán region to measure *R. solanacearum* incidence in streams and rivers. Understanding the distribution and survival of *R. solanacearum* can help prevent future epidemics.

Successful disease control principally comes from educating farmers about different preventative measures to prohibit continued contamination of farmland. During the field excursions, we performed educational outreach and visited farmers who suspected their tomato fields were contaminated by *R. solanacearum*. We began our outreach projects by asking the growers about the problems they experienced in their fields. Most conversations started with how the farmers appreciated our help because they had no aid beyond USAC. Many villages we entered spoke primarily Mayan dialects rather than Spanish, which made communication an interesting challenge. We employed traditional and modern tools of disease diagnosis and afterward educated the farmers about proper sanitation procedures to prevent additional spread of bacterial wilt based on the diagnosis. If the farmers’ fields tested positive for *R. solanacearum*, we disappointingly informed them to switch to another crop and use better sanitation procedures to prevent further field contamination. Amidst all the dispiriting news about bacterial wilt, we encouraged the farmers that tomato plants resistant to bacterial wilt would soon be available for purchase.

In addition to outreach, scientists at USAC and UW-Madison are developing various tomato lines resistant to two specific plant diseases important to Guatemalan agriculture, tomato yellow leaf curl (caused by begomoviruses) and bacterial wilt. Our team led by Profs. Mejía and Sanchez traveled to two experimental fields in Sanarate (eastern Guatemala) and Agua Blanca (south-eastern Guatemala), where USAC tests the resistant tomato varieties. We assessed the plant disease resistance of the resistant cultivars. With continued evaluation and field-testing, the tomatoes will soon be marketable for Guatemalan farmers. Also at the Agua Blanca field site, I further gathered results of an experiment designed to determine if infection with the tomato yellow leaf curl virus could protect plants from dying of bacterial wilt. These ongoing projects will hopefully yield insight to the overall plant-microbe interactions and control of bacterial wilt in Guatemala and worldwide.

**Formative future**

My LACIS internship at USAC provided me with formative opportunities that will shape my future career in plant pathology. I carried out collaborative investigation with professors from UW-Madison (Profs. Allen and Maxwell) and USAC (Profs. Mejia and Sanchez). These international relationships broadened my research understanding with a global perspective. I worked directly with the rural farming community of Guatemala, which helped me understand the direct impact of plant pathology on agriculture. After this research and outreach stint in Guatemala, I better understand the larger purpose of my future career in international plant pathology.