



Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program

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Trip Report: Bolivia 19-25 November 2011

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Purpose of Trip: Discuss research progress, meet with research partners, Enhance development of plant microbial partnerships to support phosphorus nutrition, suppress pathogens, and improve crop sustainability. Also to assess status of conservation agriculture plots and identify challenges that might compromise the planting systems being evaluated.

Sites Visited: Cochabamba (PROINPA station) and Tiraque watershed, Bolivia

Executive Summary:

Numerous one-on-one visits, site visits, seminars and small group discussions resulted in a good understanding of PROINPA capabilities and challenges. It was decided that a traineeship for M. Claros would be the most effective way to transfer knowledge that would facilitate the overall project, but particularly to focus on learning methods to screen plant-microbial partnerships for nutrient enhancement and/or pest suppression.

Description of Activities:

Day 1 (Monday, November 21)

On their first day in Cochabamba, Testen and Cheesman were taken to PROINPA headquarters by plant pathologist Ing. Giovanna Plata. The pair first met with microbiologist Mayra Claros to discuss her research. Ing. Claros described the research of her three students on *Trichoderma* metabolites, possible mycorrhizae of quinoa (*Chenopodium quinoa*), and plant growth promotion by a Bolivian isolate of *Bacillus subtilis*.

The pair was then given a tour of the PROINPA facility by Ms. Claros. Ms. Claros described her greenhouse trials of potential plant growth promoting rhizobacteria (PGPR) and the process by which potential PGPR are screened by PROINPA. Ms. Claros also showed experiments of

PGPR colonization of potato and wheat, *Bacillus* colonization trials of radish and lettuce and a trial on the effects of bioproducts on microbial diversity and diversity of microfauna such as nematodes. There were also germination trials of quinoa seeds that were pelletized with *Trichoderma* and *Bacillus* species because farmers were getting poor germination of quinoa in their fields. The Penn State students toured PROINPA's facilities for the production of bioproducts. The pair was then shown PROINPA's germplasm greenhouse which contained achira (*Canna edulis*), yacon (*Polymnia sonchifolia*), arracacha (*Arracacia xanthorrhiza*), and several other important Andean crops. These greenhouses also contained a collection of virus free rootstocks of apple, cherimoya, avocado, peaches and grapes for sale to local farmers.

Testen and Cheesman then met Ilich Figueroa and learned about his research on sustainable management of insect pests of quinoa. Several biological controls are being researched such as the use of *Bacillus thuringiensis* and nuclear polyhedrosis virus. Pheromones are also being isolated and synthesized for control of moth pests.

In the afternoon, there was a meeting with Dr. Antonio Gandarillas, Ing. Noel Ortuño, Mayra Claros, Giovanna Plata, Pablo Mamani and AnaKarina Saavedra, Anna Testen and Hilary Cheesman to discuss the SANREM research plans and further collaborations between PROINPA and Penn State. The research being performed by the two graduate students at Penn State was discussed extensively, along with research in Bolivia that could be performed to support the research at Penn State. One of the main points of this discussion was that Bolivia would retain all rights to any isolates originating from Bolivia that were obtained in this research.

Day 2 (Tuesday, November 22)

On the second day in Cochabamba, the graduate students along with Giovanna Plata visited the target Tiraque watershed, Bolivia. Jose Olivera and Pablo Mamani led the pair to many quinoa and haba fields to observe planting techniques and disease problems. Samples of quinoa downy mildew, caused by *Peronospora variabilis*, were collected from 12 fields for further genetic analysis in the United States into diversity of the pathogen. Faba bean leaf samples were also collected from 12 fields with plants with symptoms caused by species of *Alternaria* and *Botrytis*. These were used to isolate the pathogens in Giovanna Plata's lab and the leaves were dried to send back for sequencing analysis in the United States. Many research fields in Tiraque and Toralapa were visited in this day long trip. Trials of plant growth promoting *Bacillus* and separate trials of pelletized *Trichoderma/Bacillus* quinoa seedlings were visited. The adventure of the day involved getting the research truck stuck in the mud of the Andean highlands. The truck was only freed with the help of some Andean farmers. Despite the intense rain, this fieldtrip was highly enjoyable and educational.

Day 3 (Wednesday, November 23)

On the second to last day in Bolivia, Testen and Cheesman met with Ms. Plata to discuss her research needs and how her research at PROINPA could benefit research at Penn State and vice versa. Testen will provide Ms. Plata with a pictorial protocol for maintaining *P. variabilis* downy mildew pathogen (an obligate parasite) in detached leaves along with other techniques for working with the pathogen, and a pictorial guide for morphological identification of *Bacillus* species. Testen provided Ms. Plata with a pictorial guide for isolating beneficial *Bacillus* species and producing *Bacillus* inoculum for evaluation in greenhouse and field trials. Ms. Plata also

requested information on colonization and germination assays to determine if *Bacillus* isolates can improve plant growth. Testen requested more isolates of *Bacillus* from PROINPA that had been pre-screened for plant growth promotion, phosphate solubilization and/or biological control. Testen also discussed the need for quinoa leaf tissue with quinoa downy mildew to perform genetic diversity studies on the pathogen. It was briefly discussed that Testen will also develop a rapid PCR (polymerase chain reaction, a method to amplify DNA) based detection method for quinoa downy mildew in quinoa seeds, so Testen requested seeds infected with *P. variabilis*.

In the afternoon, Testen and Cheesman presented brief 15-30 minute seminars on their research in Pennsylvania. The seminars were delivered in English because the students at PROINPA wanted to practice their English. However, the American students also wanted to practice their Spanish, so next time, the seminars will be given in Spanish.

Day 4 (Thursday, November 24)

On the final day in Cochabamba, Testen and Cheesman discussed specific experiments that could be performed at PROINPA and replicated at Penn State. One would be screening of *Bacillus* isolates for reduction of quinoa downy mildew. A known seed source of quinoa would be used. *Bacillus* isolates would be foliarly applied and plants would be challenged with downy mildew one to two weeks later. The severity of disease would then be evaluated using established methods. We also discussed that Ms. Plata would collect quinoa plants which would then be sent to the United States to be used for isolation of *Bacillus* species. Testen will prescreen for phosphate solubilization and cryo-tolerance and will also identify the bacteria. Ms. Claros will screen the isolates for plant growth promotion while Ms. Plata will screen for disease reduction.

Collaborators Met and Seminar Attendees:

Researchers	Title	Contact information
Violeta Angulo	-	v.angulo@proinpa.org
Dr. Jose Antonio Castillo	Molecular Microbiologist	j.castillo@proinpa.org
Ing. Mayra Claros	Laboratory Assistant	m.claros@proinpa.org
Ing. Jorge Crespo	Entomologist	l.crespo@proinpa.org
Dr. Javier Franco	Nematologist	j.franco@proinpa.org 591-4-4319595
Dr. Antonio Gandarillas	General Manager, ProINPA	a.gandarillas@proinpa.org 5914-4319595
Ing. Gladis Main	Technician	g.main@proinpa.org
Ing. Eduardo Navia	Horticultalist	e.rocha@proinpa.org
Ing. Giovanna Plata	Plant Pathologist	g.plata@proinpa.org
Ing. Noel Ortuño	IPM leader	n.ortuno@proinpa.org
Dr. Alberto Centellas	tree fruit Hort.	a.centellas@proinpa.org
Pablo Mamani	Agronomist	p.mamani@proinpa.org
AnaKarina Saavedra,	Soil Science	a.saavedra@proinpa.org
Jimera Irigoyen,	Ag. Product R&D	j.irogoyen@proinpa.org
Ilich Figueroa,	Entomologist	i.figueroa@proinpa.org
Jose Olivera,	Agronomist	j.olivera@proinpa.org

8 additional seminar attendees that were not identified

Recommendations

The two graduate students spent considerable periods of time discussing enhancement of phosphorus status in plants using microbial symbionts. Further, they also spent time on laboratory and field techniques for evaluating plant status for N, P and K nutrients, and delivery systems for symbionts. The general recommendation would be that one of the agronomists from PROINPA should come to Penn State for a 1 month traineeship to learn:

- A) How to isolate and grow beneficial microbes
- B) How these organisms can be grown and formulated for seed or foliage delivery
- C) How field grown crops can be evaluated for improvements in nutrient status and colonization by beneficials
- D) How to stack multiple beneficial traits into one organism

The logical person for training, after discussion with Dr. Gandarillas was Mayra Claros.

Training Report

A seminar was held in which Testen and Kessler presented their research on quinoa and faba beans. Particular emphasis was paid to delivery systems for symbionts, and to pathogens challenging key crops. A question and answer period followed that was far ranging.

Training Activities

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
Seminar	11/23/ 11	25	14	11	Penn State Grad Students— Testen and Kessler	Plant symbiont Relationships and plant growth promotion



Hilary Cheesman in faba bean field.



Anna Testen collecting samples of quinoa downy mildew.



Giovanna Plata and Jose Olivera examining quinoa in the SANREM conservation agriculture plots in Tiraque Province, Bolivia.



Pablo Mamani looking at quinoa and potato in the SANREM conservation agriculture plots in Tiraque Province, Bolivia.