RATIONALE AND OBJECTIVES

The overall vision of the Stakman-Borlaug Center (SBC) for Sustainable Plant Health is to solve challenges to plant health that impact food security and ecosystem health through interdisciplinary research, teaching, and outreach. Education and training of scientists in cereal rust prevention and control, to prevent cereal rusts from causing economical damage on crops, is part of this vision. The University of Minnesota is one of the centers of excellence for cereal rusts research, and has world-class facilities to develop high quality education and training programs on rusts prevention. The purpose of the Cereal Rusts Training Program is to provide trainees with experiential learning on methodologies for the study of cereal rust diseases. At the end of the training, it is expected that trainees will adapt at their own research centers the acquired practical and theoretical knowledge, and make a significant improvement on rust research in their own institutions.

Specific objectives: After completing the program, trainees will be able to:

1. gain theoretical knowledge of the biology, ecology, epidemiology, diagnosis, and management of cereal rust diseases
2. develop pure rust isolates, increase inoculum, and perform short- and long-term storage of isolates
3. learn race nomenclature systems, and perform race identification and analyses
4. perform greenhouse and field inoculation techniques, and disease assessment at the seedling and adult stages
5. postulate the presence/absence of resistance gene(s) in unknown wheat cultivars
6. learn to isolate and identify rusts from alternate hosts
COURSE DESCRIPTION

The Cereal Rusts Training is based on experiential learning. It emphasizes on laboratory, greenhouse, and field activities where trainees will gain practical experiences in working with cereal rusts. Practice is complemented by classroom activities (lectures and group discussions) that provide trainees with theoretical foundations on the biology, ecology, epidemiology, diagnosis, and management of cereal rust diseases. Opportunities are provided for interacting with principal scientists in S-BCRC based on trainees’ research interests.

Wheat stem rust is the core component of the training program. All the protocols and methodologies covered in the program are based on the wheat stem rust pathosystem. In addition, practice and theoretical components will include wheat leaf rust, barley leaf rust and stem rust, and oat crown rust.

- Instructor: Pablo D. Olivera (PhD), Research Associate
  Department of Plant Pathology
  University of Minnesota

- Duration: 6 weeks (June 1st – July 15th)

- Days: Monday to Friday

- Time: 08:30 a.m. – 12:00 p.m.
  01:30 p.m. – 05:00 p.m.

- Location: Plant Growth Facility
  St. Paul Campus
  University of Minnesota

Participation of SBC rust scientist

- Yue Jin  Cereal Disease Laboratory  Wheat stem rust pathology
- Matthew Rouse  Cereal Disease Laboratory  Wheat stem rust pathology
- James Kolmer  Cereal Disease Laboratory  Wheat leaf rust pathology
- Les Szabo  Cereal Disease Laboratory  Pathogen genetics and genomics
- Alan Roelfs  Cereal Disease Laboratory  Wheat stem rust pathology
- Brian Steffenson  University of Minnesota  Barley pathology
- James Anderson  University of Minnesota  Wheat breeder
- Kevin Smith  University of Minnesota  Barley breeder
- Ruth Dill-Macky  University of Minnesota  Wheat pathology
COURSE SYLLABUS

1. **Classroom**

1.1. **Lectures**
   - Introduction (history, economic importance, rust research in Minnesota)
   - TTKSK complex – a new threat for wheat and barley production
   - Biology of rusts (nomenclature, hosts, life cycles, mechanisms of variability)
   - Pathogen genetics and genomics
   - Host-pathogen interactions: compatibility and infection types
   - Rust control (eradication of barberry, genetic resistance, fungicides)
   - Rust surveys and race identification, nomenclature systems
   - Genetics of, and breeding for rust resistance
   - Gene postulation
   - Cereal rusts alternate hosts: identification, roles in pathogen variability and disease epidemiology

1.2. **Group discussions**
   - How to adapt the rust protocols to my working condition
   - Around-table discussions with rust scientists on topics of trainees’ interests
   - Paper discussions on rust biology and breeding related topics
   - Resources for rust research. How to access and use the rust research resources available, including websites, contacts information, and literature

2. **Practice**

2.1. **How to handle cereal rusts**
   - Collect field samples
   - Develop pure culture (single pustule isolation)
   - Inoculum increase
   - Store cultures (dry rust samples, storage methods)
   - Retrieve from storage (heat shock, re-hydration, germination tests)

2.2. **Planting, inoculation, and scoring of cereal rusts**
   - Planting and fertilization protocols
   - Inoculation (prepare inoculum, perform inoculation, incubation)
   - Score (review scoring scales, learn how and when to score)

2.3. **Race ID protocols**
   - Collect rust samples: where and how to collect samples, storage of samples
   - Process samples: collection of spores, inoculate differential sets, germination tests
   - Production of pure isolates: selection of single pustules, incubation, collection, and inoculation on differentials
   - Race typing: score differentials and assign race ID using the NA nomenclature system
2.4. Germplasm evaluation at the seedling stage
- Bulk vs. single races
- Learn protocols to work with bread wheat, tetraploid wheats, triticale, *Aegilops*
- Interpretation of results
- Postulate presence/absence of stem rust resistance genes

2.5. Field and greenhouse evaluations at adult stage
- Field: how to establish a field nursery, inoculation techniques (needle injection and spray), scoring (infection response and severity)
- Greenhouse: planting, inoculation, and scoring

2.6. Stem rust life cycle, working with alternate hosts
- Identification of species that are alternate hosts of cereal rusts
- Learn techniques of collection and inoculation of rusts from the alternate hosts
- Use identification series for identifying cereal rusts

2.7. DNA and molecular markers work
- Principles and uses of molecular markers in wheat and barley breeding
- Laboratory exercises on using molecular markers to identify specific $Sr$ genes

2.8. Wheat and barley breeding and pathology at the University of Minnesota
- Trainees will interact with University of Minnesota scientists who are conducting research on wheat and barley breeding and pathology (rusts and other important diseases).
- Include field and laboratory tours, lectures, and group discussions

3. Field Trips

Training program includes three field trips that complements the theoretical and practical activities conducted at St. Paul Campus

- University of Minnesota Landscape Arboretum – work with alternate hosts of cereal rusts.
- Farm in St. Charles, MN. Work with alternate hosts of cereal rusts.
• University of Minnesota, Crookston Campus, and North Dakota State University. Visit cereal pathologists, rusts survey in wheat and barley fields.

Training manual and literature:

A manual will be provided to the trainees containing all the protocols for working with the cereal rusts included in the training. In addition, a package with selected literature and lectures printouts is included.

Contact Information

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