Fusarium Head Blight

Improving Resistance and Reducing the Mycotoxins

Fusarium head blight (FHB), or scab, is one of the most important diseases in wheat and is caused by several *Fusarium* species. It causes significant losses annually, in spite of efforts during recent decades to obtain and release more tolerant varieties. Since several *Fusarium* species causing FHB produce mycotoxins that are harmful to human and animal health, there is a growing concern for food and feed safety. The mycotoxins of primary concern are the trichothecenes, of which the most common in scabby grain is deoxynivalenol (DON), produced by *Fusarium graminearum* and *F. culmorum*. New EU regulations, enforcing DON limits as low as 0.750 mg/kg (750 ppb) in flour intended for human consumption, reflect the attention given by policy makers to food safety. Thus, research aimed at minimizing mycotoxin levels in cereals is becoming a high priority.

Fusarium graminearum (teleom. *Gibberella zeae*) is the prevalent species causing scab in areas where warm and humid climatic conditions (25-30°C and RH above 85%) prevail from anthesis to maturity. Climate change is likely to be increasing the risk of FHB epidemics in several regions. Zero and minimum tillage practices are also associated with higher FHB severity in areas where wheat is grown after maize, an alternate host for the fungus. The primary inoculum source is infected crop residues, from which ascospores and conidia are released.

FHB Research at CIMMYT

CIMMYT has been working on scab resistance since the mid 1980s. In 2006, for reasons of greater screening capability, accuracy and precision, the program was shifted from Toluca to El Batán. The main advantages are the proximity of laboratory facilities for the preparation of inoculum; the ability to target precisely-calibrated inoculations to each line's flowering time; and the availability of a fine misting system.

Inoculation of *F. graminearum* using precision CO_2 sprayers at El Batán

The inoculum consists of a mixture of *F. graminearum* isolates collected during the preceding year in naturally-infected fields. After confirmation of the species and DON chemotype using PCR, strains are evaluated in the greenhouse on a range of wheat checks using a 10 μl point inoculation (50,000 conidia/ml). The most aggressive strains are kept for field screening.

In the field screening, ten spikes per row are tagged at anthesis and the whole row is inoculated. Precision CO_2 backpack sprayers are used to apply liquid inoculum (50,000 conidia/ml) at a rate of 39 ml of inoculum per meter. The inoculation is repeated 2 days later.

High throughput field screening: an automated, programmable misting system allows the screening for Type I resistance of about 9,000 wheat plots per year

CIMMYT

The screening area can accommodate up to 9,000 lines or plots, and is placed under a programmable misting system to provide uniformly humid conditions favorable to FHB. Spikes are rated in each plot at 31 days post-anthesis.

The new system and the scale of operations give CIMMYT an advantage in phenotyping mapping populations, screening and selecting for resistance against FHB. Results in CIMMYT and Austria using the same screening nursery proved to be highly correlated, underscoring the relevance and reliability of screening at El Batán. In 2006, CIMMYT began to actively place a high priority on toxin evaluation of selected trials/entries from the FHB screening nurseries. Entries with a FHB index below 10% are tested for DON using ELISA.

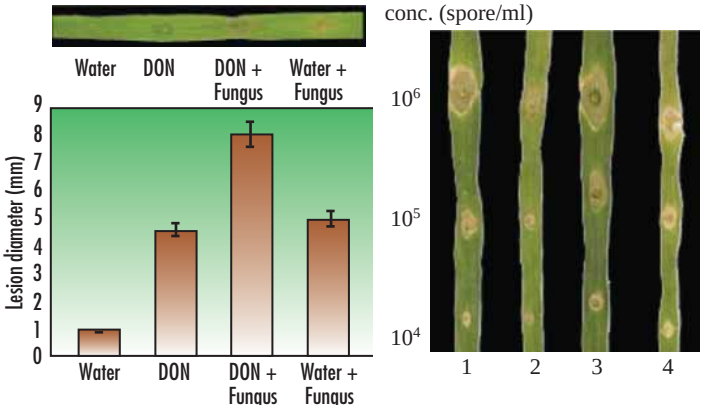
Mycotoxin evaluation using the RIDASCREEN® FAST DON ELISA kit to evaluate the DON levels

For promising materials CIMMYT also screens for Type II resistance in the greenhouse using the point inoculation method. However, since this technique is time consuming and requires growing plants to the adult stage, research is ongoing into the possibility of using a novel seedling bioassay to increase throughput and discard the most susceptible genotypes early on.

Greenhouse screening to characterize Mexican *F. graminearum* strains, and evaluate the most suitable for use in field screening, and to test wheat genotypes lines for Type II resistance

International Collaborations and Partnerships

CIMMYT's FHB program is presently participating in a series of research projects with partners in Japan, South America, USA and China. A Japan-CIMMYT collaborative project, "Breeding and Genetic Studies on Wheat Development with High Fusarium Head Blight (FHB) Resistance", funded by the Government of Japan, allowed CIMMYT to establish a state of the art field screening system at El Batán in Mexico, and to identify sources of resistance to FHB that are as good as Sumai 3.



Novel seedling bioassay system for FHB molecular interaction using mycotoxin (DON) with primary leaves (Murakami & Ban, 2005)

The Japan-CIMMYT collaboration with JIRCAS and the Kihara Institute for Biological Research (Yokohama City University) contributes to advanced research in genotyping and on molecular markers. Through the USWBSI and funds from USDA, a collaboration with the USDA-ARS Small Grains Genotyping Center, Fargo (North Dakota) was initiated to use molecular markers to determine how resistance sources submitted to CIMMYT from various breeding programs compare with known sources of resistance, such as Sumai 3. With Nanjing Agricultural University and support from NSF (China), phenotyping of mapping populations based on Wangshuibai resistance is being conducted at El Batán. Other partners include UCL (Belgium), Uruguay, Italy (Mycored, 7th EU framework program) and Germany (BMZ/University of Bonn). One of CIMMYT's objectives is to assess the severity of FHB and DON levels under conservation agriculture practices using long term agronomy trials.

The Scab Resistance Screening Nursery

CIMMYT has regularly developed and distributed a Scab Resistance Screening Nursery (SRSN). These nurseries have consisted of the best scab-resistant material identified through CIMMYT's FHB screening trials, and have been distributed to interested programs around the world upon request. The 12th SRSN is being distributed in 2009. The entries have been tested for at least two years under the new screening system and selected based on low FHB indices in the field and low DON levels. Molecular tools are increasingly used to ensure a maximum diversity among the materials distributed.

For further information:
E. Duveiller, Head, Wheat Pathology (E.Duveiller@cgiar.org)
M. Mezzalama, Head, Seed Health Unit (M.Mezzalama@cgiar.org)
March 2009