



# An Electronic, Multi-Access Key for Diagnosing Disease, Arthropod and Abiotic Problems of Small Grains

National Plant Diagnostic Network Meeting  
January 28-31, 2007

Ronda Koski<sup>1</sup>, Will Lanier<sup>2</sup>, and Ned Tisserat<sup>1</sup>

<sup>1</sup>Department of Bioagricultural Sciences & Pest Management, Colorado State University, Fort Collins, CO 80523-1177

<sup>2</sup>Department of Department of Animal and Range Science, Montana State University, Bozeman, MT 59717-2900

## Background Information:

A successful commodity-specific Integrated Pest Management (IPM) program is dependent upon rapid and accurate identification of the cause of a crop problem. Information pertaining to pests (arthropods and pathogens) and abiotic disorders associated with wheat and other small grains currently exists in various formats (books, compendia, and facts sheets), and much of this information is available via the Internet. Pest management decisions significantly impact crop yield and producer profitability, as well as the health of the cropping ecosystem and surrounding environment. In order to better benefit wheat producers, currently available wheat pest information needs to be organized into a comprehensible, comprehensive, and portable diagnostic package that is linked to management information, and can be easily updated.

## Project Purpose:

To provide growers, crop advisors, extension agents, diagnosticians and others associated with the production of wheat and other small grains (a.k.a. stakeholders) with commodity-based, multi-access (multi-entry), multi-media, electronic keys to aid in the diagnosis (identification) of the cause and management of crop production problems.

## Benefits of Multi-Access Keys:

Database of key contains information about all the entities (taxa) that can be identified with that particular key.  
The matrix of scored features (characters) in the key's database is checked each time a question about the specimen (unknown) is answered.  
The user can identify an unknown entity by choosing key character states that best describe the specimen.  
The user can start with any key feature, and can proceed in any order.  
The user can skip over features that are difficult to describe or those features that are not appropriate for or applicable to the specimen.  
Multi-access keys do not suffer from the "unanswerable couplet" problem encountered with most dichotomous keys.

## Lucid Builder and Lucid Player Software:

Lucid™ Builder™ is a cross-platform Java-based software program for the development and deployment of interactive multi-access keys. Lucid™ Builder will run on any Java-enabled operating system. Lucid™ Player™ is required in order to use a key developed with Lucid™ Builder. Lucid™ Player is an easily downloadable player software, available at no-cost from Lucid Central (<http://www.lucidcentral.org>).

Entities that have the selected character state(s) are retained in the "Entities Remaining" panel. Entities that do not match the chosen character state(s) are progressively eliminated (placed in the "Entities Discarded" panel), until only one entity, or a few possible entities, remain in the "Entities Remaining" panel. Relevant fact sheets, images, and web sites can be linked to features and entities to provide further information for confirming identification of the specimen in question.

\* Developed by Centre for Biological Information Technology, at The University of Queensland, in Brisbane, Australia (<http://www.cb.it.uq.edu.au/>).

## Project Funding:

Funds that make this project possible are provided by:  
U.S.D.A. Regional Integrated Pest Management Competitive Grants Program ([http://www.csrees.usda.gov/funding/rfas/ipm\\_western.html](http://www.csrees.usda.gov/funding/rfas/ipm_western.html))  
Great Plains Diagnostic Network (<http://www.gpdn.org/DesktopDefault.aspx>)

## Key Development Procedures:

Accumulated information and images pertaining to the arthropod pests, diseases, and abiotic disorders associated with wheat and other small grains. Organize collected information into spreadsheets and folders. Using Lucid™ Builder 3.3 and the collected information, an alpha version of a multi-access diagnostic key to problems associated with wheat production in the United States has been developed. The key is currently being evaluated for accuracy. Images and links to additional sources of information will be incorporated into the beta version. The key will contain links to illustrated fact sheets contained in the High Plains Integrated Pest Management Guide (<http://www.highplainsipm.org>). The beta version of the key will be released to a limited number of stakeholders for evaluation during the 2007 cropping season. Feedback from the beta-version evaluators will be used to make additional improvements on the key. The final version of the key will be published fall of 2007 on the LucidCentral website, where it will be available, along with Lucid™ Player, free of charge, to stakeholders and other interested individuals.



Above:  
Lucid™ Builder 3.3  
Tree View tab  
Depicting Media, Features and Entities Panels

Right:  
Lucid™ Builder 3.3  
SpreadSheet Scoring tab  
Depicting scored matrix

How are the smutted kernels arranged in head?

What part of the plant is exhibiting symptoms?

Insects were ruled out as the cause of the problem based on the states selected!

Left:  
Lucid™ Player  
Depicting use of key to identify a wheat sample afflicted with loose smut.