

Scab News

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Scab Research Initiative Underway with Glickman Announcement of \$3 Million Funding Boost

Fusarium head blight or scab has indeed gained prominence as a national research problem: The U.S. Department of Agriculture has a total budget of about \$86.5 billion in 1999, \$792 million of which is Agricultural Research Service programs. Yet last March, USDA Secretary Dan

Glickman singled out scab, and officially announced at a national farm meeting that the USDA will spend an additional \$3 million per year on research to combat the fungal disease.

“This is a substantial, needed boost to our already aggressive, national effort to stop scab,” Glickman said at

the announcement.

No wheat and barley varieties are immune to scab, which is responsible for almost 500 million bushels of wheat lost in the U.S. since 1991, with economic losses valued between \$1.3 billion to \$2.6 billion, according to university and industry estimates. A toxin that may be produced from scab called deoxynivalenol (DON or vomitoxin) can make barley unacceptable for malting and brewing, and wheat unacceptable for milling.

Congress appropriated \$500,000 to boost scab research efforts in fiscal year 1998. This funding allowed initial phases of a U.S. Wheat and Barley Scab Initiative to begin. The additional \$3 million appropriated in FY99 has allowed more of the Initiative’s scab research plan to get underway. This research involves dozens of crop scientists in 20 states, with much of the work carried out at land-grant universities in scab-threatened areas.

Research program focus areas of the Initiative include variety development and coordinated screening nurseries; epidemiology (how scab develops and spreads) and disease management; food safety, toxicology, and utilization; biotechnology; germplasm introduction and evaluation; and chemical and biological control.

USDA’s ARS distributed the new funds to university researchers and ARS research facilities this spring, as shown on the map at left.

Grant amounts do not reflect institutional administrative costs that vary with each university and research facility. ■

Where Scab Research is Taking Place



University of Arkansas,
Fayetteville, Ark. - \$39,000

University of Georgia,
Athens - \$15,000

University of Illinois,
Urbana - \$87,000

Purdue University,
West Lafayette, IN - \$126,000

Kansas State University,
Manhattan - \$34,000

University of Kentucky,
Lexington - \$49,000

Louisiana State University,
Baton Rouge - \$15,000

University of Maryland,
College Park - \$5,000

Michigan State University,
Lansing - \$410,000

University of Minnesota,
St. Paul - \$338,000

University of Missouri,
Columbia - \$122,000

University of Nebraska,
Lincoln - \$86,000

Cornell University,
Ithaca, N.Y. - \$45,000

North Carolina State University,
Raleigh - \$44,000

North Dakota State University,
Fargo - \$833,000

Ohio State University,
Wooster - \$135,000

South Dakota State University,
Brookings - \$160,000

Virginia Polytechnic Institute and State
University, Blacksburg - \$39,000

Washington State University,
Pullman - \$29,000

ARS Crop Improvement and Utilization
Research Unit, Albany, CA - \$50,000

ARS Bioactive Agents Research Unit,
Peoria, Ill. - \$72,000

ARS Soybean and Alfalfa Research
Laboratory, Beltsville, Md. - \$45,000

ARS Cereal Disease Lab,
St. Paul, Minn. - \$90,000

ARS Plant Science Research Unit,
Raleigh, N.C. - \$15,000

ARS Cereal Crops Research Unit,
Fargo, N.D. - \$50,000

ARS Cereal Crops Research Unit,
Madison, Wis. - \$35,000

Defining the U.S. Wheat & Barley Scab Initiative

Webster defines the word “initiative” as “the first step; opening move.” It also means “the power, ability, or instinct to begin or to follow through energetically with a plan or task.” These are fitting words for the U.S. Wheat and Barley Scab Initiative.

Scab has been one of the most serious production problems for wheat in the 1990s, and the fungal disease has proven devastating to U.S. malting barley.

The disease prompted researchers and members of the wheat and barley industry to seek solutions through a federal research initiative. What started as a patchwork of ideas is now a comprehensive, multi-disciplinary, multi-institutional research initiative involving dozens of crop scientists in 20 states.

In one sense of the word, the Initiative has been realized. The

research plan is in place, and so is the funding (although we hope this funding can be stepped up to allow more components of the plan to be undertaken). The Initiative is moving beyond that first organizational step, which has been quite trying these past few months for researchers waiting for federal funding to be put in place, so they may launch their research projects.

Now that the funding is in place, in another sense of the word, the Initiative is just beginning. Now the work begins, to follow through with our research plan. Good communication and coordination will play a major role in the success of this Initiative. The research efforts of this Initiative need to be coordinated so the plan stays on course and the “left hand knows what the right hand is doing,” so to speak. Researchers

involved with the Initiative need to communicate with each other about progress. As well, this progress needs to be communicated with producers, lawmakers, and other members of the public.

In addition, we need to make sure accountability is built into the system, so that the monies for this Initiative are invested in the most efficient manner. The steering committee overseeing the Initiative feels that it is very important to demonstrate accountability all the way through this research effort.

The U.S. Wheat and Barley Scab Initiative now has an engine. However, it is up to all who wish to vanquish scab to keep the engine running. ■

Rick Ward, Michigan State University wheat breeder and Tom Anderson, Barnesville, MN wheat producer, co-chairs, U.S. Wheat and Barley Scab Initiative

FOOD SAFETY, TOXICOLOGY, AND UTILIZATION

Sampling and Analyzing DON in Wheat & Barley

Sampling and analyzing DON (a contaminant produced by scab) in wheat and barley is a major role for this area of the Initiative, says Pat Hart, cereal scientist at Michigan State University. Scab researchers can submit samples for DON analysis at MSU and North Dakota State University. Scab researchers who want more information on sampling size and shipping protocol should contact Hart or Howard Casper at NDSU, ph. 701-231-7529, email:

hcasper@ndsuxt.nodak.edu.

Along with DON analysis, a second project at NDSU supported by the scab initiative involves the evaluation of methodology to limit Fusarium growth and damage of barley during malting, according to Paul Schwarz, NDSU cereal scientist. Alteration of malting process parameters, the use of chemical additives, and biological control will be studied.

Hart says MSU toxicology researcher James Pestka is in the process of adding personnel to focus on food toxicology research,

as it relates to DON. Hart is adding personnel to assist in improving DON diagnostic and detection techniques, and he is overseeing a study on representative DON sampling from truckloads of grain. This study has been conducted for two years, with another two years planned for completion. □



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Evaluating Fungicide Application Techniques

A semi-permanent greenhouse for fungicide application studies was built at NDSU in the fall of 1998, and became fully operational with lights and heat by January, 1999, according to Marcia McMullen, NDSU plant pathologist. The greenhouse was federally funded through the FY98 Initiative, which also helped fund a seven-state uniform fungicide evaluation trial in 1998.

Over 30 different application treatment trials have been conducted since application studies began at the end of February, 1999. Evaluations (using the spring wheat variety Russ, Munich durum, and Robust barley) have included percent dye coverage plus fungicide efficacy, as determined by head severity measurements following inoculation and misting. Spray variables evaluated included nozzle type, spray pressure, water gallons, and adjuvants. "We hope to have all of this information collated, analyzed and ready for delivery in early May, so that growers will have updates on optimum spray techniques for nozzles tested and for crop type," says McMullen.

This year, McMullen and Gary Bergstrom, Cornell University plant pathologist, are coordinating a 14-state cooperative uniform fungicide trial for scab control. The research study includes 10 treatments, involving some standards plus experimental products. The 14 states are NY, MA, KY, AR, NC, VA, MO, OH, MI, IN, IL, ND, SD, and MN. The uniform trial will include several classes of wheat, as well as barley in ND and MN. "We



Jim Moos and Scott Halley, research technicians at North Dakota State University, are calibrating a greenhouse track sprayer used to analyze fungicide application effectiveness. The sprayer is capable of converting to various nozzles, pressures and speeds, and gallons of water. An orange dye is used to indicate percentage of wheat and barley head coverage from a test fungicide application in the greenhouse. Photo: Marcia McMullen

should get some valuable information from these trials," says McMullen.

Bergstrom says Fusarium biocontrol research under the National Initiative begins in earnest at Cornell this summer, with the hiring of Christine Stockwell as postdoctoral research associate. Stockwell will conduct research and testing on potential antagonists that may be applied to cereal seeds, spikes, or crop residues for control of scab.

Also, Bergstrom says field tests are being conducted in New York on spikes of winter and spring wheat of a promising Fusarium antagonist, a Bacillus strain isolated from the roots of wheat plants. He says that in previous greenhouse tests, this strain reduced scab and markedly reduced the vomitoxin

content of grain. This antagonist is being evaluated by itself and also in combination with the fungicide Folicur. The fungicide and biological control field evaluation also includes a biocompatible fungicide, potassium bicarbonate, in the form of Armicarb, newly registered for crop use by Church and Dwight Co., manufacturer of Arm and Hammer baking soda products.

Bergstrom says an Ohio State University/USDA-ARS-Peoria biocontrol group is also planning field tests with prospective Fusarium antagonists. □

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The Quest for Scab Resistant Sources

Breeding scab-tolerant varieties will be one of the critical factors in managing scab. However, breeding is hindered by a lack of adequate resistant sources. This is the key challenge for researchers leading the germplasm introduction component of the U.S. Wheat and Barley Scab Initiative.

Yue Jin, plant scientist at South Dakota State University, says that objectives of this area of Initiative research for spring wheat, an ongoing effort in close cooperation with varietal development efforts, are to: 1) search for new sources of scab resistance through introduction and evaluation of spring wheat germplasm; 2) maintain and characterize identified resistant materials; 3) facilitate germplasm and data exchange; and 4) integrate new resistance genes into adapted materials.

Germplasm is being sought from other regions of the world where scab is a problem, including eastern Asia, eastern Europe and South American countries. Even wild relatives of wheat and related grasses will be evaluated. Promising germplasm is evaluated through replicated trials over multiple locations, via a Uniform Regional Scab Nursery and Uniform Regional Yield Trials, currently in place in the spring wheat region, and being organized in other regions. This component of the project will increase gradually as the number of selections increase, says Jin.

Elias Elias, NDSU durum breeder, says that last October, 400 durum accessions (germplasm test material) were obtained for scab evaluation from the Small Grains Germplasm Collection in Aberdeen, Idaho. In November 1998, a total of 500 accessions were sent to the Academy of Agricultural Sciences, Plant

Protection Institute in Shanghai, China to be evaluated for FHB in the 1998-99 growing season. Also, Elias says 50 accessions were sent to Groupment Agricole Essonnois (GAE) in France for evaluation.

Disease readings at both locations took place in May depending on environment, plant growth stage, and disease development, with complete evaluation results expected in June. Elias says additional durum accessions will be obtained from the Small Grains Germplasm Collection for evaluation in the next growing season (1999-2000) in China, where scab is a problem. "The FY99 funding will help evaluating this material," says Elias.

Since last fall, the University of Missouri has evaluated just under 1,000 winter wheat accessions from China, Japan, Brazil, and Italy, according to Anne McKendry, University of Missouri winter wheat breeder.

Greenhouse work over the winter is finished, and field studies are underway this spring. Close to 4,000 winter wheat plants were screened for type II (spread in the head) scab resistance. "We have several lines that appear to have high levels of resistance, which we will be cycling through the greenhouse again and verify before the next scab forum," says McKendry. She says the goal is to also identify useful traits other than scab, such as maturity, winter hardiness and resistance to powdery mildew, Septoria species, barley yellow dwarf virus, and leaf rust.

She says there are 66 lines in the winter wheat germplasm being evaluated that are earlier maturing than the winter wheat variety Ernie, the earliest check in the material. □

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FHB Jottings

Initiative staff member named

One component of the U.S. Wheat and Barley Scab Initiative is the Networking and Facilitation Office (NFO) at Michigan State University. Jennifer Wagester (gottsc10@pilot.msu.edu) just signed on to manage the NFO under the direction of Rick Ward. The NFO will manage the Initiative's website (www.scabusa.org), organize meetings, and facilitate the work of the steering committee. "We are here to help further the Initiative's work in any way we can," says Wagester.

Scab scientists to explore research linkage with China

Olin Anderson, USDA-ARS Western Regional Research Center, Albany, CA; Anne McKendry, University of Missouri; and Rick Ward, Michigan State University, will travel to China in October, 1999, on an ARS-sponsored research exchange (funded separate from the U.S. Wheat and Barley Scab Initiative) to explore partnerships in biotechnological wheat research between the U.S. and China, and scab research linkages.

International Wheat Scab Symposium planned

A four-day international symposium to exchange information and explore new approaches to develop scab resistance is being organized by the Cytogenetics Institute, Nanjing Agricultural University, China. The symposium will be held next April, in Suzhou, Jiangsu, China, where scab epidemics occur frequently and where resistant germplasm Sumai #3 was developed. For more

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Research Monitors Fungal Spore Levels

This area of research involves assessing inoculum management and disease forecasting, the effects of different variables including moisture in the scab infection process and inoculum production, and understanding ascospore (the fungal spores that cause scab) survival, deposition, and accumulation on plant surface.

A cooperative project involving Len Francl at NDSU, Yue Jin at SDSU, Pat Lipps at Ohio State University, and Greg Shaner at Purdue has been initiated to monitor fungal inoculum (spores) levels on a daily basis and weather conditions occurring during the 1999 growing season, in regions where scab is known to cause yield losses. Fungal inoculum levels and weather conditions will be recorded using advanced equipment in order to develop a predictive system to help forecast disease development.

Environmental influences on spore development and discharge are being investigated at Michigan State University by Frances Trail (more details on her work may be found on the MSU web page: <http://www.bpp.msu.edu/research.html>). Understanding of conditions (moisture and temperature) that lead to spore production and release will help fine-tune disease forecasting systems and ultimately disease control.

At SDSU, Jin is conducting studies on possible moisture effects on inoculum production and ascospore survival. Over the past several months, Jin has focused on the development of a survival curve for ascospores under a greenhouse environment. The aim is to assess the viability of ascospores trapped on plant surfaces, and ways to assess scab inoculum potential. Field plots have been established to repeat these experiments under field conditions.

Projects headed by Robert Todd at NDSU and Ruth Dill-Macky, University of Minnesota, are investigating



Erick Dewolf, a post doctoral researcher working on the scab epidemiology and forecasting project at Ohio State University, is checking a Burkard cyclone spore sampler, used to monitor the amount of spores of Fusarium in the air. The equipment is supported by the U.S. Wheat and Barley Scab Initiative. Photo: Pat Lipps

survival of Fusarium in crop residues, with residue decomposition studies well underway. Corn, wheat, oats, and barley residue is being incubated under varying nitrogen fertility levels and in various surface/subsurface configurations. Dill-Macky will also be investigating the effect of burning crop residues on survival of fungal inoculum and disease development.

At the University of Illinois, Wayne Pedersen is investigating the effect of various cropping practices (tillage and crop rotations) on scab development and associated diseases on wheat. Plots were established last fall and Pedersen reports that at present, there is no difference in plant stands between tillage systems or following corn or soybeans. There is a much higher incidence of Fusarium root rot on wheat in the plots following corn, both no-till (27%) and tilled (18%) than following soybeans (6%).

Steve Leath, North Carolina State University/USDA-ARS, is continuing

studies on a survey of Fusarium of wheat in the southeast wheat growing regions of the U.S. So far, only Fusarium graminearum has been found, and there was variation in toxin production and aggressiveness among the more than 60 isolates found on three different varieties.

Andy Jarosz, Michigan State University and Robert Bowden, USDA/ARS Cereal Disease Lab, St. Paul, are actively making arrangements to sample populations of Fusarium graminearum in ND, MN, MO, and MI this growing season. They have formalized techniques for isolating and storing the fungus, and have examined a DNA extraction procedure to begin the process of genetically characterizing the populations. □



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More Tolerant Wheat lines on the Way

Spring wheat breeding programs at North Dakota State University, South Dakota State University, and the University of Minnesota, have all developed wheat lines with better scab tolerance, and are now increasing seed from those lines for varietal release this year and in 2000, according to Jackie Rudd, SDSU spring wheat breeder.

The USDA's Agricultural Research Service and the U of M this spring released McVey, a new spring wheat variety which offers better scab tolerance than most other current varieties, and the first transitional variety to maintain high yields. Seed from McVey is being increased by certified seed growers this year for general public release and production next year.

Rudd says the more-tolerant spring wheat lines being developed come from Sumai 3, a Chinese source of resistance. Other sources of resistance are also being used,

but are not as far advanced.

"They are a step above what we have now, with better scab tolerance and acceptable agronomic characteristics, such as yield," says

A comprehensive story on ARS scab research around the country, including development of the spring wheat variety McVey, is in the June issue of ARS' "Agricultural Research" magazine. It may be found online at the USDA-ARS website: <http://www.ars.usda.gov>

Rudd. "Whether we can reach our goal of complete immunity, we don't know. Obtaining scab resistance may be similar to

breeding for yield, where there is no top or ceiling but small steps. We do know we are making definite, measurable progress."

Federal funding under the U.S. Wheat and Barley Scab Initiative will allow spring wheat breeding programs, already immersed in breeding for scab tolerance, to expand the testing and evaluation of lines in the field, in the greenhouse, and in winter nurseries, says Rudd. The Initiative will allow institutional research programs that don't have these facilities and capabilities, or are just starting them, to launch or expand their varietal development programs targeting scab.

Herb Ohm, winter wheat breeder at Purdue University, says that similar to other programs, he plans to have a soft red wheat variety with "type II" resistance (inhibiting scab from spreading throughout the wheat head) in a few years. This past year, Purdue released the soft red variety Goldfield, as well as another licensed variety, that have a low incidence of scab. It is not type II resistance; rather, the varieties have a more enclosed spikelet formation that helps prevent fungal spores from infecting the wheat during flowering.

"We have, because of the Initiative, more nurseries for varietal evaluation and selection," says Ohm. "We are greatly expanding our program to transfer resistance from several sources of resistance into our adapted sources, which we want to do as soon as possible."



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Industry Seeks Increase in FY00 Scab Research Funding

Close to 50 state and national industry organizations from producers to millers and brewers are urging Congress to increase funding for scab research in the FY00 federal budget. In a letter sent to lawmakers in May, the groups pointed out that Congress has already approved language authorizing spending of \$5.2 million for the U.S. Wheat and Barley Scab Initiative, and that Congress should now appropriate that amount.

"The bottom line is that Fusarium head blight will only be solved through research. Until then, the disease will remain a threat to (wheat) and malting barley production in the United States," the groups said, in the letter. ■



Biotechnology's Role in the Fusarium Fight

B iotechnology is still relatively new to wheat and barley research, including scab research. However, more research attention is being placed on using genetic engineering to: 1) identify genes in wheat and barley that are involved in the scab defense response, by mapping scab resistance genes with molecular markers, which essentially are road signs or tags to mark regions of the plant chromosomes that carry scab resistance genes; 2) identify and insert antifungal genes in wheat and barley from other wheat and barley germplasm or other organisms, including bacteria and fungi; 3) identify and insert genes that can detoxify deoxynivalenol (DON) a contaminating byproduct of scab.

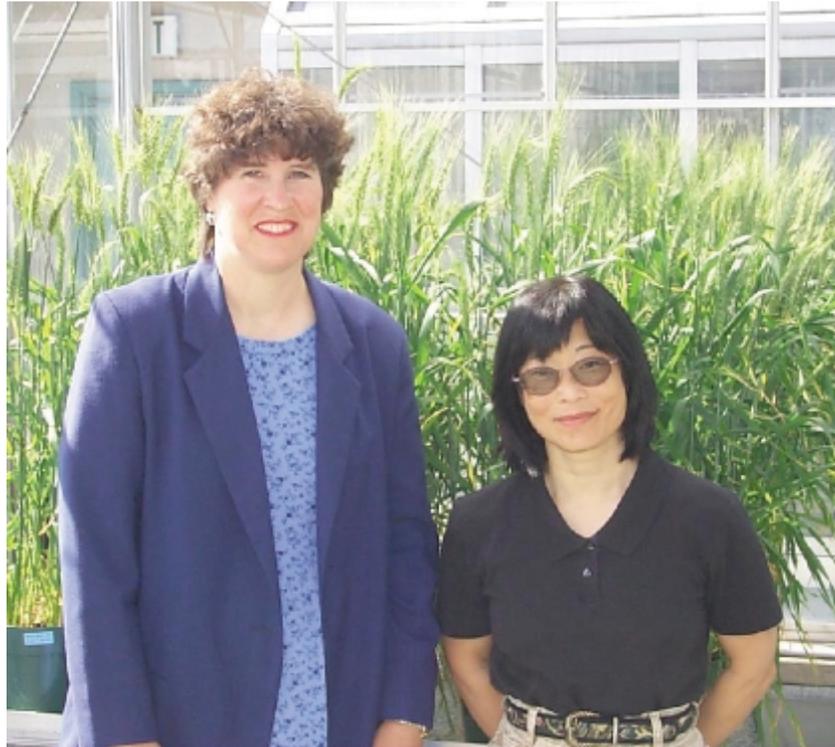
The national scab initiative will help provide the resources needed to focus on these research objectives, says Olin Anderson, supervisory research geneticist at the USDA-ARS Western Regional Research Center, Albany, CA.

Gene transformation progress is already being made at labs involved with the initiative, including the University of Minnesota, University of Nebraska, and USDA-ARS labs in Peoria, IL, Fargo, ND, and Albany.

A more comprehensive look at the biotechnology area of the U.S. Wheat and Barley Scab Initiative will be featured in the fall scab initiative newsletter, with features of other primary research areas of the Initiative to follow in subsequent newsletters. □



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A key objective of the biotechnology area of the national scab initiative is to insert anti-fungal genes into wheat and barley varieties. Two researchers involved with this effort are Patricia A. Okubara, (right) and Anne Blechl, at the USDA-ARS Western Regional Research Center, Albany, CA. They and others in their research group have a number of lines of the winter wheat variety Bobwhite successfully transformed with two candidate anti-Fusarium genes, TR1r and PDR5, that are intended to target the fungal toxin. Researchers have also engineered and introduced several genes for proteins that might attack or break down the cell wall or membranes of the Fusarium fungus. Photo: Gerard Lazo

National FHB Forum set for Dec. 5-7 in Sioux Falls, SD

MARK YOUR CALENDAR: The next U.S. Fusarium Head Blight Forum will be held Dec. 5-7, 1999, at the Ramkota Inn (Hwy. 38 East and I-29, ph. 605-336-0650) in Sioux Falls, SD. The format will be similar to that of last year's forum in Michigan. At the forum, research recommendations will be finalized for submission to USDA-ARS, in request for FY00 funding. A request for research grant proposals will be announced to crop scientists sometime in July, and due in September. Look for further details on the next forum in the Fall Newsletter. ■

Barley Breeders Increasing Screening Efforts

In barley, we have prioritized each year what needs to be done for our Fusarium head blight research,” says Rich Horsley, six-row barley breeder at NDSU. “One item that has come up each year that needs to be done is screening of the USDA small grains collection for spring six-rowed accessions with FHB resistance. However, funding has not been available to do this screening under uniform disease conditions in mist-irrigated nurseries.”

The Initiative, however, will allow that to occur. Horsley says that over the next two years, NDSU barley researchers will screen about 7,500 spring six-rowed barley accessions or test lines from the USDA small grains collection for FHB resistance. These accessions will be grown in mist-irrigated nurseries near Langdon, ND and Osnabrock, ND and will be inoculated with *Fusarium graminearum*. DON content will be determined on the accessions with the lowest

levels of FHB, and evaluated on check cultivars (i.e. Foster, Stander, Chevron, MNBrite) grown in the nurseries.

Horsley says the new federal funding allowed NDSU to increase the size of the mist-irrigated nursery near Osnabrock by 60 percent, to automate the mist-irrigated system at Langdon, and to hire personnel (two undergraduates and one research technician) to assist researchers working in the nurseries.

The University of Minnesota is also stepping up its screening efforts, and evaluating several sources of resistance, says Don Rasmusson, U of M barley breeder. A technician has been added to the U of M barley breeding program. Further, Kevin Smith has joined the U of M as assistant professor of barley breeding and genetics research. Smith, who started Dec. 1, 1998, will work in close collaboration with Rasmusson for a two-year period, prior to Rasmusson’s retirement. ■

FHB Jottings • *from page 5*

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APS web site features Fusarium

The American Phytopathological Society, based in St. Paul, MN, spotlighted Fusarium head blight on its web site (www.scisoc.org) during the month of May. The comprehensive feature (still posted) includes information compiled by Robert Stack, a member of APS and a North Dakota State University plant pathologist. Other literature on scab was also included, as well as links to other online scab resources.

Online scab research bibliography developed

The USDA-ARS Cereal Disease Laboratory, St. Paul, MN, has developed an online Fusarium head blight (scab) bibliography: <http://www.cdl.umn.edu/databases.html>. Mark Hughes (markh@puccini.crl.umn.edu), a research biologist at the CDL, says the site currently has over 2,500 citations and will continue to be expanded as researchers submit material. The bibliography is searchable by author, date, and key words. □

Scab Initiative Newsletter

This newsletter is made possible by the U.S. Wheat and Barley Scab Initiative. For more information about the Initiative, or to submit news items for consideration in this quarterly publication, contact Rick Ward, Michigan State University wheat breeder and Initiative co-chair/director of the Initiative's Networking and Facilitation Office, 382 PSSB, Michigan State University, East Lansing, MI 48824, Phone 517/285-9725, Fax 517/353-3955, Email: wardri@pilot.msu.edu.

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