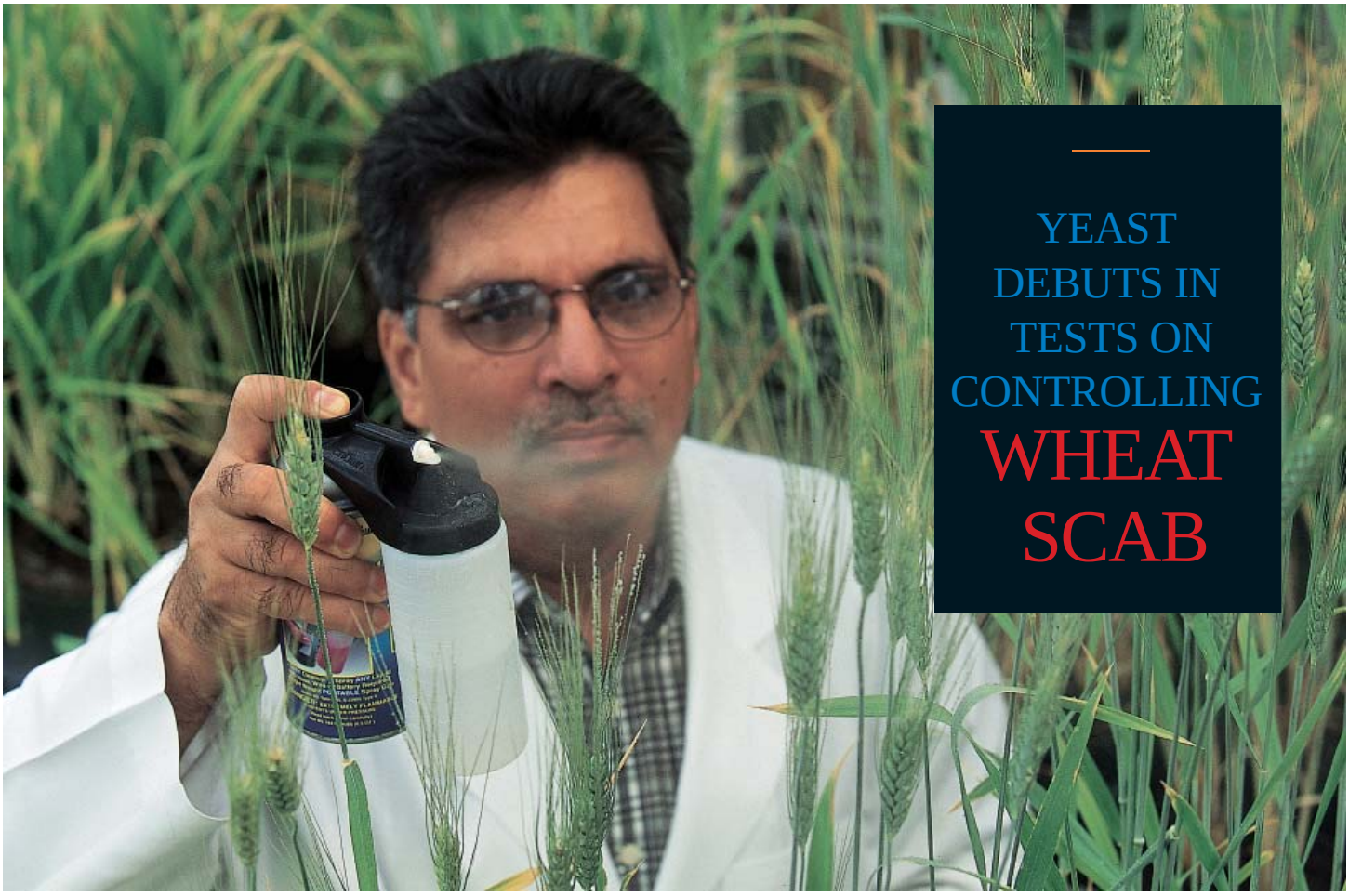
KEITH WELLER (K9452-6)



YEAST DEBUTS IN TESTS ON CONTROLLING WHEAT SCAB

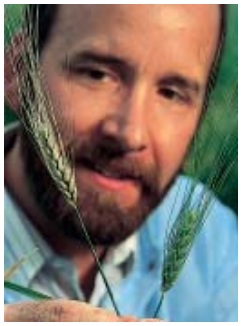
To reduce the severity of Fusarium head blight, Ohio State University plant pathologist Naseem Khan sprays a solution containing *Bacillus* bacteria cells onto wheat heads.

Summer 2001 marks the beginning of the first wide-scale field tests that will compare chemical power to biological strategies for controlling Fusarium head blight, the disease also called scab.

Since early spring, ARS researchers led by plant pathologist David A. Schisler have been busy supplying 13 cooperating state agricultural experiment stations with cultures of the yeast *Cryptococcus nodaensis* as a biological control standard-bearer for the test.

Schisler and his colleagues at the National Center for Agricultural Utilization Research (NCAUR), in Peoria, Illinois, grow the yeast in 20-liter bioreactors. Formerly known as fermentors, bioreactors provide precisely the environment of nutrients, aeration, temperatures, and other conditions needed to help microbes such as *C. nodaensis* reproduce at top speed. After about 48 hours, the researchers empty the bioreactors and process and freeze the yeasts for field tests. One-liter batches are used to start the next round of fermentation.

KEITH WELLER (K9450-16)



Plant pathologist David Schisler examines two wheat seed heads inoculated with the causal agent of scab. The one on the right was sprayed with biocontrol microbes that greatly reduced disease symptoms.

Caused by the fungus *Fusarium graminearum*, the disease is named "scab" because of the whitish-grey discoloration that forms on wheat or barley grains. In the past decade, farm losses to scab have been estimated at more than $3 billion in the United States. Outbreaks in wheat and barley have been especially severe in Illinois, Indiana, Michigan, Minnesota, North Dakota, Ohio, and South Dakota. *F. graminearum* can also cause root, stalk, and ear rots in corn.

With plant pathologists Michael J. Boehm and Naseem I. Khan of Ohio State University (OSU), Schisler has screened nearly a thousand yeasts and bacteria for their fungus-control ability. The U.S. Department of Agriculture (USDA) has applied for a patent jointly with OSU on seven microbes presently considered most promising. Applied to wheat as it begins to flower, the beneficial microbes, according to one theory, produce chemicals that inhibit growth of the disease fungi. Or in some cases, the "good guy" microbes may gobble up nutrients that ooze from the anthers—male organs in the seed head. When the wind blows *Fusarium* spores onto the

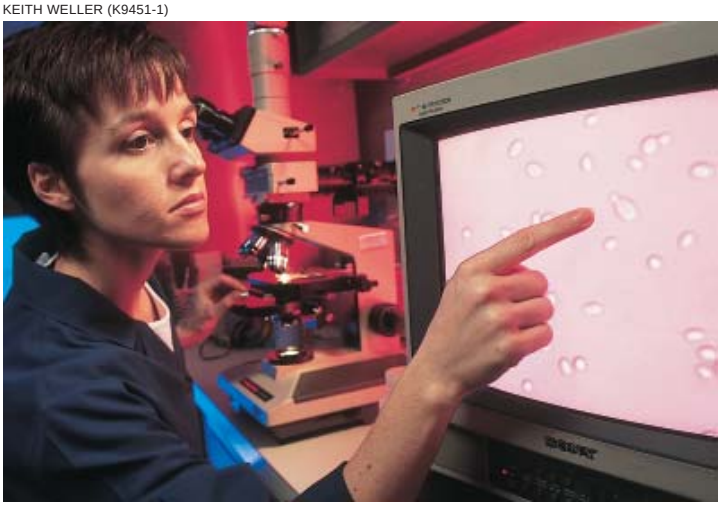
anthers, little if any nourishment is left. The culprit fungi may then never gain a foothold to damage the developing kernel deeper inside the flower.

Wheat scab research at NCAUR and OSU is funded in part by a USDA National Research Initiative Grant. Some of the research is being funded by the Dakota Growers Pasta Company. Durum wheat, used to make pasta, is produced mainly in North and South Dakota and Canada. The company became interested in funding biological control of scab research after seeing results of preliminary field trials.

If the research continues to underscore the microbes' potential, a company may decide to license them and do what's needed to make them commercially successful. Such efforts would involve research on scaled-up production and automated processing, some of which could plausibly be done at NCAUR's newly renovated pilot plant facility, says center director Peter B. Johnsen.

From among the "magnificent seven" microbes, one is a yet-unnamed strain of a yeast that is new to science, according to NCAUR microbiologist Cletus P. Kurtzman. In 3 years of field tests at a few locations, all these microbes have shown promise, several reducing disease severity up to 80 percent. Because the microorganisms may reduce disease in different ways, they might be applied in combinations.

KEITH WELLER (K9451-1)



Using a video monitor and a light microscope, technician Jennifer Ierulli studies yeast cells while several bud to form new cells.

Inasmuch as late-applied chemical fungicides could leave chemical residues on wheat used for food, few have been registered for use during the critical time of pathogen infection—wheat flowering through early kernel development. If some microorganisms prove resistant to damage from a chemical fungicide, they could be applied along with the fungicide. "That should reduce the amount of chemical fungicide needed and may reduce the chance of the pathogen's developing resistance to the fungicide," says Schisler.

"Considering the labor and logistics needed to prepare for field tests at 13 state agricultural experiment stations, we had to choose just one microbe to prove the biological-control concept," says Schisler. The researchers weighed their choices according to several considerations, one of which was the microbes' resistance to registered and experimental fungicides. Other considerations included how massively and quickly yeast cells reproduced in the bioreactors, their ability to survive and remain healthy in storage, and how effectively they worked after storage in arresting the growth of *F. graminearum*.

Commercial and experimental fungicides, along with the yeast and a strain of the bacterium *Bacillus subtilis*, are being compared in annual field tests known as the Uniform Wheat Fungicide Trials. Research on the bacterium was conducted at Cornell University. The trials, a cooperative project funded by USDA and state agricultural experiment stations, will provide direct comparisons of scab-control measures in various environments, from year to year. The experiment stations include those in Arkansas, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Missouri, New York, North Dakota, Ohio, South Dakota, and Virginia.

While the Uniform Wheat Fungicide Trials proceed, Schisler and his colleagues continue to search for microbes with enhanced biological control potential, attune their bioreactors to produce high yields of various microbial strains, find ways to ensure the strains survive well in storage, and test those strains in the field.

The NCAUR scientists' early laboratory and collaborative field research on biological control of scab also provided impetus for international cooperation in problem solving. Liubov V. Kolombet, a microbiologist and chief of the Department of Antimicrobial Agents for Plant Protection at the State Research Center for Applied Microbiology at Obelinsk, Russia, visited Schisler at NCAUR for 3 weeks to formulate a proposal for a grant from the ARS-FSU (Former Soviet Union) Science Cooperation Project. The research proposal involves strains of *Trichoderma* fungi that have been researched at the Russian institution. Someday these fungi may be applied as a seed coating to make plants better fit to resist scab as they approach maturity.—By **Ben Hardin,** ARS.

This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at http://www.nps.ars.usda.gov.

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