April 2005

Red River Valley Agricultural Research Center

RESEARCH NEWS FROM THE VALLEY

USDA-ARS-RRVARC Fargo, ND

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From the Director

"*April showers bring May flowers*"

Translation: Some unpleasant occurrences bring about better things – The New Dictionary of Cultural Literacy, Third Ed. 2002

Spring again breathes new life into the Red River Valley, for which we in Fargo are very grateful. We had two and a half days of gentle, cleansing mid-April showers, followed by warm days, which quickly greened up the grass. And now we look forward to the daffodils, tulips, and flowering crabapple trees soon to bloom in May.

The Showers…

A new "season" has also arrived at the Red River Valley Agricultural Research Center. As most of you are aware, our Center Director for the past five years, Dr. Larry Chandler, left Fargo in November 2004 (this is the "showers" part) and moved to Fort Collins, CO, where he assumed his new post as Associate Area Director of the Northern Plains Area.

During his tenure at the RRVARC, Dr. Chandler energized the Center through gentle but firm leadership. In his unpretentious style, he identified and sought out customers and stakeholders and brought them into a partnership with the scientists and technicians at the Center. Dr. Chandler organized annual meetings of the RRVARC Partners that provided a forum for stakeholders to express research needs that RRVARC research units could address. We will miss Dr. Chandler's leadership at the RRVARC.

The May Flowers…

On the bright side of this transition, Dr. Chandler raised the visibility of the RRVARC significantly, and he now assumes a role of even greater responsibility within the Northern Plains Area. We believe that this is a very positive development for research at the RRVARC. For the time being, Dr. Chandler continues to oversee the administration of the Sclerotinia Initiative, a federally funded program to combat this devastating disease in many broadleaf crops. The research of the Sclerotinia Initiative is conducted by federal and university scientists through funding to the RRVARC.

More Flowers…

Meanwhile, with its visibility and reputation at a new high, the RRVARC was able to attract several excellent candidates for the vacant position of Center Director. On April 7, Dr. Will Blackburn, Area Director, announced the appointment of Dr. William (Bill) Kemp as Center Director of the RRVARC. Until his appointment here, Dr. Kemp most recently served as a Research Leader at the ARS facility in Logan, UT. Dr. Kemp will assume his duties in Fargo on July 10, 2005.

Bill Kemp…

Dr. Bill Kemp received his Ph.D. in Forestry, Wildlife and Range Sciences from the University of Idaho (1984), his M.S. in Entomology from Michigan State University (1978), and his B.S. in Wildlife Management from the University of Maine (1976). He has more than 20 years of experience with USDA-ARS, beginning as a Research Entomologist at the Rangeland Insect Laboratory in Bozeman, Montana.

(Continued on page 2.)

PASS IT ON!!!!

Feel free to pass on this issue of *News from the Center* to others interested in agricultural research in the Northern Plains Area. To be added to our mailing list contact Alicia Thompson by phone (701-239-1370), fax (701-239-1395), or e-mail (thompsoa@fargo.ars.usda.gov).

From the Director (cont'd)

Dr. Kemp is internationally recognized as an expert on grasshoppers, Mormon crickets, solitary bees, and insect/environment interactions. He has more than 105 publications, shares one patent and three CRADAs, and has frequently presented his research findings at international and national meetings, symposia, and workshops.

Dr. Kemp worked on the population dynamics and modeling of forest insect pests at the University of Idaho prior to joining ARS. He conducted research on grasshoppers from 1984 through 1996 at the ARS Rangeland Insect Laboratory, Bozeman (and Sidney), MT, and was appointed Research Leader in 1994.

Dr. Kemp also served as Editor of Environmental Entomology, an international journal published by the Entomological Society of America, from 1989 to 1995. He joined the ARS Pollinating Insect Biology, Management, & Systematics Research Unit, Logan, UT, as Research Leader in 1997.

As a Research Leader since 1994, Dr. Kemp has excelled in leadership functions at three ARS locations. We look forward to July 10, when Dr. Kemp begins his leadership role at the RRVARC. Please feel free to drop in or make a phone call to introduce yourself or organization to Dr. Kemp upon his arrival.

In this issue…

In this issue of "Research News from the Valley", we again share with you some of the recent events and research activities that have taken place during the past several months. We appreciate your interest and support of our numerous research programs.

Thanks to all of you!

Brady Vick
Interim Center Director

Northern Crop Science Laboratory
Fargo, ND

Photo taken by Larry Harrington Photography, Inc.

Biosciences Research Laboratory
Fargo, ND

Photo taken by Larry Harrington Photography, Inc.

National Sclerotinia Initiative Update

The USDA-ARS National Sclerotinia (white mold) Initiative annual meeting was held in Minneapolis, MN, on January 18-20. Approximately 80 participants provided research updates, discussed customer and stakeholder needs, and outlined new research directions and long range plans to address integrated disease management development. Additionally, the Initiative Steering Committee met on February 25 to make decisions on research needs. A total of 29 research projects were funded to university and ARS researchers across the United States at a total cost of $1.27 million for 2005.

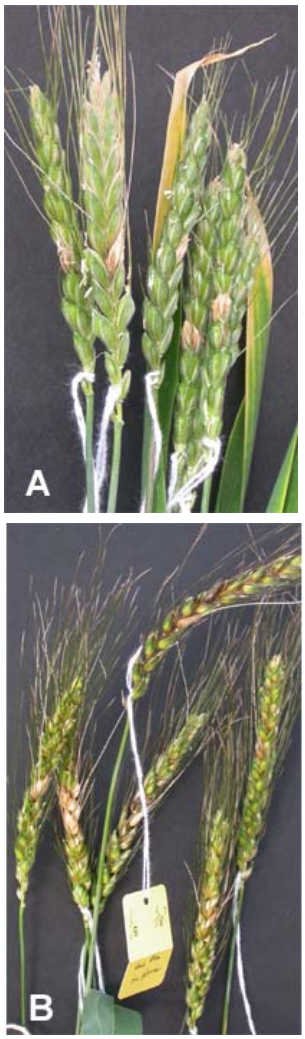
Research is focused on developing new disease control options in canola, dry beans, peas, lentils, soybean, and sunflower. The Initiative continues to be an outstanding example of multi-agency cooperation and is making great strides in finding solutions to effectively manage this important disease. For more Information check out the Sclerotinia Initiative website at: www.whitemoldresearch.com

For more information, contact Dr. Laurence D. Chandler, Associate Area Director, USDA-ARS-Northern Plains Area Office, Ft. Collins, CO. larry.chandler@ars.usda.gov

A PROGRAM OF THE

USDA ARS

Evaluation of Tetraploid Wheat Germplasm for Resistance to Fusarium Head Blight



Reaction to point-inoculated Fusarium head blight in a cultivated emmer wheat plant (A) and a Persian wheat plant (B) showing low levels of infection.

Fusarium head blight (FHB), commonly known as scab, is a destructive fungal disease of wheat and barley in humid growth conditions throughout the world. In the last decade, FHB epidemics in the United States and Canada have caused serious yield losses. In fact, direct economic losses to wheat and barley production were estimated at $2.5 billion from 1993-2001. When combined with secondary losses, the total for the period rises to $7.7 billion (Nganje et al. 2004).

The most effective and cost-efficient strategy to combat FHB is to deploy cultivars carrying genetic resistance.

Resistant sources of hexaploid bread wheat (*Triticum aestivum* L., 2*n* = 6*x* = 42, AABBDD genomes) have been identified, such as the Chinese cultivar Sumai 3 and its derivatives, Brazilian cultivar Frontana and Eastern European germplasm Praag 8. However, resistant sources have not been discovered in tetraploid durum wheat (*T. turgidum* L. subsp. *durum*, 2*n* = 4*x* = 28, AABB) and attempts to transfer resistance from hexaploid sources have not been very successful.

In addition to durum wheat, there are seven other tetraploid subspecies, including Persian wheat (*T. turgidum* subsp. *carthlicum*), wild emmer wheat (*T. turgidum* subsp. *dicoccoides*), cultivated emmer wheat (*T. turgidum* subsp. *dicoccum*), Polish wheat (*T. turgidum* subsp. *polonicum*), oriental wheat (*T. turgidum* subsp. *turanicum*), Georgian emmer wheat (*T. turgidum* subsp. *paleocolchicum*), and poulard wheat (*T. turgidum* L. subsp. *turgidum*). They all have the same AABB genomes as durum. Among these tetraploid wheat subspecies, only wild emmer wheat has been extensively evaluated for FHB resistance. However, the resistance in wild emmer wheat has not been successfully used in durum wheat breeding because of linkage drag, such as seed shattering and late maturity. Unlike wild emmer, the other six tetraploid subspecies all exist in cultivated form. Desirable traits in these cultivated tetraploid wheats could be easily transferred to durum wheat by conventional breeding approaches.

The USDA National Small Grains Collection (NSGC) in Aberdeen, ID, currently maintains 95 accessions of Persian wheat, 619 of cultivated emmer wheat, 4 of Georgian emmer wheat, 81 of Polish wheat, 110 of oriental wheat, and 455 of poulard wheat. These tetrapoid germplasm collections have not been evaluated for resistance to FHB. To identify the best possible sources of FHB resistance for durum wheat breeding programs, we systematically evaluated 653 accessions from the NSGC for resistance to FHB over two seasons in the greenhouse.

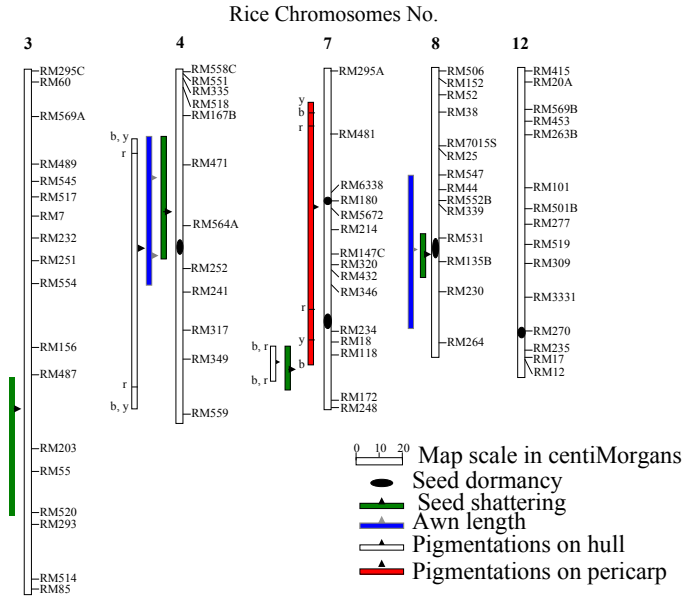
Different subspecies exhibited a different average reaction to FHB. Similar to durum wheat, most accessions of Polish, oriental, and poulard wheats were highly susceptible to FHB. However, a number of accessions of Persian wheat and cultivated emmer wheat showed various levels of resistance to FHB. Most interestingly, six accessions of Persian wheat (PI 283890, PI 94748, PI 352281, PI 94754, PI 286070, and PI 61102) and four accessions of cultivated emmer wheat (PI 79899, PI 41025, CI 14135, and CI 7686) showed a level of resistance similar to that of Alsen, a Sumai 3 derived hard red spring wheat cultivar in North Dakota. These accessions could serve as novel sources of resistance to develop durum wheat germplasm or cultivars resistant to FHB. In addition, Persian, cultivated emmer, oriental, Polish, and poulard wheats are still cultivated in some countries in the Middle East and Europe. Particularly, the farmers in Europe remain interested in planting hulled wheats, including cultivated emmer wheat. In the US, limited amounts of spring emmer are grown in scattered areas throughout Montana and North Dakota. Therefore, the FHB resistance present in cultivated emmer wheat could be directly used in development of commercial emmer wheat cultivars.

Reference:

Nganje, W.E., Kaitibie, S., Wilson, W.W., Leistritz, F.L., and Bangsund, D.A. 2004. Economic impacts of Fusarium head blight in wheat and barley: 1993-2001. Agribusiness and Applied Economics Report No.538 (53p).

For more information, contact Dr. Michael C. Edwards, Research Leader, Cereal Crops Research Unit, at edwardsm@fargo.ars.usda.gov

Weedy Rice as a Model for Seed Dormancy Investigations



Seed dormancy is a critically important adaptative trait in weeds and is important to impart resistance to preharvest sprouting in cereal grain crops. Drs. Michael Foley at USDA-ARS and Xingyou Gu and Shahryar Kianian at North Dakota State University are using weedy rice as a model plant to investigate seed dormancy.

Several years ago the dormant weedy rice strain SS18-2 and the non-dormant rice breeding line EM93-1 were cross-pollinated, and a backcross segregation population was used to construct a framework genetic map. The genetic map, germination, and quantitative trait loci (QTL) analysis techniques revealed six dormancy QTLs and several epistatic interactions in the population. Epistasis is the interaction of two or more genes or QTLs that facilitates networking. One QTL on chromosome 7 (*qSD7-1*) is of particular interest because it co-locates with a red pericarp color gene. Such genes have known associations with dormancy in other species, e.g., wheat.

In the course of evaluating dormancy through germination assays, the level of four other easy-to-score weedy traits segregating in the mapping population was measured. The traits were pericarp color, hull color, seed shattering, and presence of an awn. Statistical analysis revealed an interrelationship between seed dormancy and the weedy form of these traits, i.e., red pericarp color, black hull color, shattering, and presence of an awn.

In a follow-up study to determine the genetic basis for this statistical association, the team discovered that four shattering, three awn-length, two hull color, and one pericarp color QTL in the population were bracketed or flanked by four of five genomic regions harboring a dormancy QTL.

Very recently, a phenotypic selection and recurrent backcrossing technique was used to introduce the weedy rice-derived dormancy QTLs into the nondormant rice breeding line. Analysis of the progeny verified the co-location of dormancy QTLs with the QTLs/gene for the interrelated weedy traits.

Demonstration that networks of dormancy genes play a sheltering role in maintaining intact groups of interrelated QTLs or gene (haplotypes) for weedy traits reveals the sophisticated nature of adaptation in weeds. Moreover, knowledge of these tight linkages may prevent useless efforts by others to use the dormancy genes found in haplotypes for breeding programs aimed at imparting resistance to preharvest sprouting.

In the next few years the team will concentrate on map-based cloning of the QTL *qSD7-1* because its chromosomal interval contains the red pericarp color gene, *Rc*. Red grain color gene has long been associated with dormancy in wheat and the association has been hypothesized as a pleiotropic effect (one gene having multiple effects) of the homoeologous red color genes (*R1* to *R3*). Map-based cloning of *qSD7-1* will facilitate testing this hypothesis using a tractable model species.

For more information, contact Dr. Michael E. Foley , Research Leader, Plant Science Research Unit, at foleym@fargo.ars.usda.gov

Measuring the Genetic Diversity in the Tarnished Plant Bug (Lygus)

Tarnished plant bug, *Lygus lineolaris*.

Lygus bugs are a genus of closely related plant feeding insects with a broad host of weeds and cultivated crops. The tarnished plant bug, *Lygus lineolaris*, is North America's most widely dispersed member of this group. They attack a wide array of economically significant plants across the nation. In the northern Plains they are mostly noticed in canola, sugarbeets, alfalfa, and sunflowers. In the southern USA they are a significant pest of cotton. There have long been questions about whether the insects that feed on sugarbeets versus sunflowers are the same or if they constitute genetically distinct populations.

Similar questions arise about insects that are separated geographically, e.g North Dakota versus Mississippi. Distinct genetic populations could require alternative IPM procedures. DNA-based genetic markers are being used to measure the genetic diversity between these populations. Initial testing of a small number of insects indicates a modest amount of variability in local populations. Interestingly, the genetic difference between two insects from the Red River Valley (RRV) appears to be similar to the difference between a RRV insect and one from Mississippi suggesting that major partitioning of tarnished plant bug populations has not occurred. These preliminary results were recently presented to the International Symposium on the Ecology and Management of Lygus, held in Ottawa, Ontario, Canada. The symposium was organized to bring together the latest research on the biology of *Lygus* species, biocontrol possibilities and other IPM approaches to *Lygus* control. The meeting attracted about 50 scientists from the USA, Canada, and Europe. This research is being conducted by Dr. Richard Roehrdanz, Geneticist, Insect Genetics & Biochemistry Research Unit, Fargo in collaboration with Dr. Mark Boetel and graduate student Prasad Burange of the North Dakota State University Department of Entomology.

For more information, contact Dr. James S. Buckner, Research Leader, Insect Genetics & Biochemistry Research Unit, at bucknerj@fargo.ars.usda.gov

Dr. Horvath Gives Invited Talk at Montana State University

Dr. Horvath, Research Plant Physiologist in the Plant Science Research Unit, was recently invited to present the subject of using genomics as a novel and developing tool in weed science to a group of gifted and talented freshmen and high school students at Montana State University. The subject was presented over three sessions from April 11-13, and included discussions on genomics and model systems, use of computer resources, and a session on potential novel means to combat leafy spurge infestations.

Dr. Horvath was also asked to present a special departmental seminar on his work using microarray analysis to understand dormancy in the perennial weed leafy spurge. The invitation was tendered by Dr. David Sands, from the department Plant Science and Plant Pathology at MSU, following his meeting with Dr. Horvath at the annual meeting of the Weed Science Society of America in Honolulu, HI, in February 2005

For more information, contact Dr. David P. Horvath, Plant Physiologist, Plant Science Research Unit, at horvathd@fargo.ars.usda.gov

Developing Plant Resistance to Sunflower Insect Pests

There is a need to provide economical, non-chemical, management tools for the sunflower producer to reduce losses from the spectrum of insect pests that attack the crop in the major production regions. The use of plant resistance can be a useful tactic in a long-term integrated pest management approach for crop protection.

The sunflower stem weevil is a pest of cultivated sunflower that, in the past, has caused yield losses in North Dakota. Since the mid-90s damage has also been reported in the central Plains production region of eastern Colorado and western Kansas. Adult stem weevils lay their eggs in sunflower stalks. The larvae tunnel in the stems and chew overwintering chambers into the stem cortex. If larval populations in a plant are high, the stem is weakened by tunneling, pith destruction, or overwintering chambers, and will break, causing a loss of the head prior to harvest.

The banded sunflower moth has been a consistent sunflower pest in the northern Plains and also has been increasing in numbers in the central Plains. Adults emerge from the soil beginning in mid-July and are present in the field until mid-August. Adults congregate in field margins on weeds or adjacent crops during the day and then move into the crop in the evening to lay eggs on the outside of the developing sunflower head. Larvae feed in the heads destroying the florets, developing seed, and mature seeds.

The sunflower moth is another pest of cultivated sunflower that is responsible for yield losses, primarily in the central Plains. Larvae overwinter in the soil in the southern Plains and adults are carried on northerly winds to the central and northern Plains. Females deposit eggs in blooming sunflower heads, where the larvae feed and develop, destroying seeds and reducing oil content.

The red sunflower stem weevil is a sunflower pest in both North and South Dakota. Larvae overwinter in the soil and adults emerge in July, depositing eggs in developing sunflower seeds. Larvae feed and develop in the seeds, destroying a portion of the kernel and reducing oil content.

A team of scientists in the Sunflower Research Unit composed of Dr. Larry Charlet, (entomologist), Dr. Jerry Miller, (geneticist), and Dr. Gerald Seiler, (botanist), have conducted trials in cooperation with university scientists for the past several years in the central and northern Plains to screen sunflower accessions, interspecific crosses, and parental breeding lines to identify those having lower stem weevil densities in the stalks. The lines are also screened for reduced seed damage from larval feeding by the seed weevil and the two moth species. Screening nurseries for the stem weevil and sunflower moth are located at Colby, KS, in cooperation with Kansas State University. Plots for screening banded moth and seed weevil resistance are located in South Dakota, in cooperation with SDSU, and in North Dakota with NDSU. Results from these studies have revealed promising germplasm for all the insects studied. After each year of testing the lines, accessions, or interspecific crosses with low damage have been retested to confirm their resistance to attack. Potentially useful germplasm is currently being crossed and will be subjected to field testing in 2006.

The discovery of germplasm that has lower insect damage will provide the seed companies with breeding material to be incorporated into hybrids targeted to locations where specific insect problems occur. A long-term goal is to identify germplasm with resistance or tolerance to more than one insect pest.

For more information, contact Dr. Gerald J. Seiler, Acting Research Leader, Sunflower Research Unit, at seilerg@fargo.ars.usda.gov

Adult Sunflower Moth

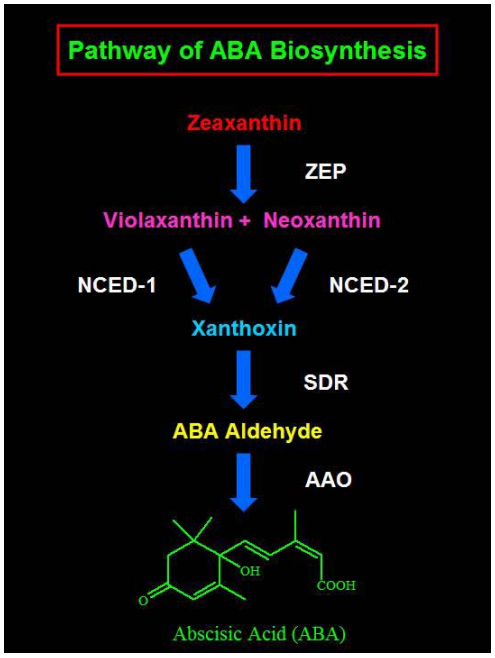
Insect screening nursery at Kansas State University NW Research Extension Center, Colby, KS.

Adult Red Sunflower Seed Weevil

Adult Sunflower Stem Weevil

Adult Banded Sunflower Moth

Genetic Control of Hormone Biosynthesis in Potatoes



Abscisic acid (ABA) is a plant hormone that regulates numerous agriculturally important processes in plants, including seed germination, water-use efficiency, and stress mitigation. In potato tubers, previous research from this unit has demonstrated that ABA plays a critical role in both the initiation and maintenance of tuber dormancy, and preliminary results suggest an equally important role in tuber wound-healing. Although the pathway of ABA biosynthesis in plants is known, the biochemical steps controlling its production in tubers have not been identified. As a first step toward identifying control points in ABA biosynthesis and ultimately manipulating ABA content in tubers, collaborative research from the laboratories of Drs. Jeff Suttle and Ed Lulai has resulted in the identification, molecular cloning, and sequencing of genes coding for all four committed steps in ABA biosynthesis in potato tubers (see figure). Using gene-specific sequences together with quantitative real-time polymerase chain reaction (qRT-PCR), the tissue content of each of these genes has been determined in tubers during dormancy progression and wound-healing. All gene transcripts (copies) are present in extremely low abundance in tuber tissues and most likely would not have been detected without the use of qRT-PCR. Interestingly, our studies suggest that although the same enzyme (NCED) may control ABA biosynthesis in both situations, it is being encoded by separate genes (NCED 1 during wound-healing vs. NCED 2 during dormancy). In addition to being the first of their kind in tuber tissues, these results suggest that it will ultimately be possible to manipulate ABA content for tuber dormancy control and improved wound-healing independently.

For more information, contact Dr. Jeffrey C. Suttle, Research Leader, Sugarbeet & Potato Research Unit, at suttlej@fargo.ars.usda.gov

Dr. Shelver's Trust Fund Cooperative Agreement with ABRAXIS, LLC

Weilin L. Shelver, of the Animal Metabolism - Agricultural Chemicals Research Unit, has established a Trust Fund Cooperative Agreement with Dr. Fernando Rubio, President of ABRAXIS, LLC, for a joint research project on the development of magnetic particle immunoassay and immunoaffinity columns for polybrominated diphenyl ethers (PBDEs).

Polybrominated diphenyl ethers are persistent environmental contaminants (flame retardants in electronic equipment and in textiles) that can accumulate through food chains. Currently, Dr. Rubio evaluated 11 antibodies generated from Dr. Shelver's laboratory and has made a magnetic particle assay kit. The assay is very sensitive and can recognize the most predominant compounds in this class (BDE-47 and BDE-99) at the 17 parts per trillion (ppt) level (1 ppt is approximately the size of one sheet of paper compared to the entire state of North Dakota). The assay is very specific toward PBDEs; other pesticides such as Aroclor 1254, PCP, or 2,4-D do not interfere with the assay. In addition, the assay is fast; fifty results can be obtained in about one hour, and it eliminates the need for expensive instrumentation and solvent disposal.

Currently, the kit can measure PBDE levels in different water samples (municipal, reservoir, lake, pond, and creek). In the near future Drs. Shelver and Rubio plan to expand the kit's ability to test the PBDEs in soil, as well as food samples.

For more information, contact Dr. Gerald L. Larsen, Research Leader, Animal Metabolism & Ag. Chemical Research Unit, at larseng@fargo.ars.usda.gov

RRVARC Participates in Marketplace for Kids

Once again staff of the Research Center participated in the 2005 Marketplace for Kids held on May 3rd at the FargoDome, Fargo, ND. Marketplace for Kids is a yearly event co-sponsored by U. S. Senator Kent Conrad, North Dakota Agriculture Commissioner Roger Johnson, and North Dakota State Superintendent of Public Instruction Wayne Sanstead. The event encourages children to invent and market a product or an idea. Over 2,400 fourth, fifth, and sixth graders from schools throughout the Red River Valley participated in this year's event.

RRVARC Ambassadors

Several organizations, including the RRVARC, had display booths highlighting their services. At the RRVARC booth children learned about the research activities at the Center. Our exhibits included baby goats, live potato beetles, plant and weed identification, and a demonstration of gel electrophoresis. Gel electrophoresis, a new display, allowed students to observe the separation of rainbow-colored molecular weight markers on an agarose gel. In addition to our display booth, staff members presented classes on the use of native plants and animals and on the wonderful world of insects.

For more information, contact
Dr. Brady A. Vick,
Interim Center Director at
vickb@fargo.ars.usda.gov


Baby goats were popular.


The gel electrophoresis display.


A busy booth.

Interacting with the students.

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RED RIVER VALLEY AGRICULTURAL RESEARCH CENTER

Vision Statement

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Upcoming Events:

EVENTS AT THE CENTER

MAY 2005

19: Dr. Qing X. Li, University of Hawaii, RRVARC Seminar, Fargo, ND, BRL-LCR, 2 pm, "Antibody & Antibody Kinetics for Small Molecules: Environmental Applications".

JUNE 2005

16: Dr. Luis Destefano-Beltran, RRVARC Seminar, Fargo, ND, NCSL-LCR, 10 am, "Molecular Cloning & Expression Analysis: ABA Biosynthetic Genes During Potato Tuber Dormancy".

JULY 2005

10: Dr. William (Bill) P. Kemp officially becomes Center Director of the USDA-ARS-RRVARC, Fargo, ND.

AUGUST 2005

SEPTEMBER 2005

EVENTS ELSEWHERE

MAY 2005

17-19: National Program 303 (Plant Diseases) Stakeholder Workshop, Orlando, FL.

21-27: 3rd International Wheat Quality Council Conf., Manhattan, KS

JUNE 2005

2-6: 7th Annual Plant Sciences Symposium, Ames, IA

4-7: In Vitro Biology Annual Meeting, Baltimore, MD

5-8: Genotyping Lab Meeting, Raleigh, NC

10-14: 2005 Biochemistry & Molecular Biology of Plant Fatty Acids & Glycerolipids Symposium, Fallen Leaf Lake, CA

21-23: 23rd Annual NSA Summer Seminar, Spearfish, SD

JULY 2005

13-16: 2005 NPC Summer Meeting, Twin Falls, ID

15-16: Colorado Sugarbeet Research Tour, Ft. Collins, CO

16-20: American Society of Plant Biologists Annual Meeting, Seattle, WA

17-20: 2005 IAAP International Convention & Education Forum, Denver, CO

17-20: 18th North American Barley Researchers Workshop, Red Deer, Alberta, Canada

17-21: 89th Annual Meeting of the Potato Association of America, Calgary, Canada

17-22 16th Triennial Conference of the EAPR, Bilbao, Spain

23-27: CRYO-2005, Annual Cryobiology Meeting, Minneapolis, MN

25-29: Beet Sugar Agricultural School, Lethbridge, Canada

30-August 3: Annual Meeting of the American Phytopathological Society, Austin, TX

AUGUST 2005

21-26: Dioxin 2005, Toronto, Canada

SEPTEMBER 2005

11-14: American Assn. of Cereal Chemists Annual Meeting, Orlando, FL

12-16: Intl. Symposium on Biological Control of Arthropods, Davos, Switzerland

26-29: 13th Annual NAWMA Conf., Manhattan, KS