

Wheat Diseases/Vectors: Integrated Management, Diagnostics, and Germplasm Evaluation (Approved July 2012)

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This proposal represents the combined research and outreach on wheat diseases and vectors of the South Dakota Pathology Group and includes both collaborative and individual projects. It addresses diseases that impact wheat yields, production and the sustainability for South Dakota wheat producers. It allows the scientists to focus their expertise on individual problems in their major areas of emphasis and to pool their expertise for collaboration on certain wheat disease and management issues.

Objectives

Stakeholder Education and Outreach:

- Author pathogen, vector, and disease based Extension materials covering bacterial leaf streak, Wheat Streak Mosaic Virus (WSMV)/wheat curl mite, barley yellow dwarf virus (BYDV)/aphids, common root rots and others.
- Hold quarterly meetings of the South Dakota Plant Pathology Working Group.
- Conduct educational Wheat Walks for stakeholders.

Development and Evaluation of Wheat Germplasm for Disease Resistance:

- Evaluate Advanced Yield Trial (AYT)-Crop Performance Trial (CPT) winter wheat lines performance when infected with WSMV.
- Collaborate in developing winter wheat varieties with pyramided disease resistance.
- Evaluate germplasm for disease reaction to fungal pathogens.
- Pre-breeding for disease resistance to fungal and bacterial diseases.

Management, Identification, and Characterization of Plant Diseases and their Vectors:

- Foliar and seed fungicide evaluations, recommendations, and disease management.
- Identify the local WSMV and mite vector “green bridge” to tailor SD WSMV management.
- General survey of 2012 wheat diseases.
- Leaf spotting fungal pathogens characterization.

Joint Objectives:

Development of educational materials for stakeholders and other agricultural professionals.

Justification, Rationale, and Approach

Education is one of the strongest tools in providing the stakeholders with the knowledge needed to identify and manage diseases in their wheat. The following diseases have been selected by the South Dakota Plant Pathology Working Group for developing educational materials this year:

- Bacterial Leaf Streak,
- Wheat Streak Mosaic Virus and the Wheat Curl Mite,
- Barley Yellow Dwarf Virus and its Aphid Vectors, and
- Common Root Rots.

Unanticipated emergent wheat disease problems during the year may require the development of additional materials, and these will be addressed as they arise.

Continuing wheat disease research and disease management outreach for South Dakota stakeholders:

Justification, Rationale and Approach -- South Dakota stakeholders need the delivery of research-based information generated by scientific research individuals and teams to provide the most current understanding and management recommendations. Personnel replacements, changes in contracted assignments, relocation of plant pathologists to diverse buildings or cities, and Extension restructuring have challenged maintaining interactions between plant pathology projects focusing on wheat and other SD crops. The Plant Pathologists have formed the South Dakota Plant Pathology Working Group to address these problems and aim to foster collaborations between wheat and other plant pathology researchers and extension personnel through quarterly meetings focusing on South Dakota disease issues in order to identify newly emerging disease issues, assess long term disease problems, and enhance collaboration between research and extension. Increased interaction and exchange will promote the flow of research information to extension personnel and provide research personnel with access to the most current developments in the producer's fields. Meetings will promote development of research on emergent wheat diseases. Publications on wheat diseases in current development will be facilitated and future publications for development will be targeted during these meetings.

Extension Plant Pathology Field Research Objectives

Principal Investigator Ruden

Development and evaluation of chemical and integrated disease management strategies.

- *Justification:* Wheat diseases caused by fungi can be managed through many methods, including seed treatments, foliar fungicides and cultural methods. Studies over many years have established that fungicide applications can reduce disease severity on wheat, with regard to foliar diseases such as tan spot, Septoria diseases, and leaf rust.
 - Leaf rust can be a problem in seasons with appropriate environment and inoculum levels, and this year appears that it could be a year with high leaf rust levels based on reports from wheat pathologists in the southern U.S. who have found rust extremely early this year. The combination of favorable environments, the emergence in the past years of new wheat leaf rust races, and the suspected development of a stripe rust race that can multiply in warmer conditions increases the risk of significant disease on the South Dakota wheat crop. Accordingly, the potential for beneficial responses to a fungicide application is also increased and needs to be assessed.
 - The critical component of Fusarium head blight (FHB) control continues to be fungicide management when it is integrated with varietal resistance, cultural practices and disease risk assessment. This project is testing a group of fungicides and biological control agents at different timings in winter and spring wheat to determine the most effective way of managing FHB and mycotoxins. The project is also evaluating specific management plans for efficacy in managing FHB and DON in winter wheat, spring wheat and barley as part of a coordinated project with other cooperators around the United States as part of US Wheat & Barley Scab Initiative (USWBSI).
- *Approach:* Spring and winter wheat disease plots will be established at several locations across the state to determine the effectiveness of several fungicides that are currently available or may become available to the producers in the near future.
- *Methods:* Winter wheat trials: Seed treatment, foliar fungicide and scab suppression trials are located at the Volga and NE Research Farms for the 2012 season. Spring wheat trials: Seed treatment trials will be planted at the NE Research Farm and Volga; foliar fungicide and scab suppression trials will be planted at Volga, NE Research Farm and Groton for the 2012 season.

Develop and deliver educational tools to help with targeting critical wheat pest management issues through research trials, publications, and programming.

- *Justification:* The research-based information generated through field plots trials will be disseminated to South Dakota growers and to the allied industries. Extension bulletins will also be used as an educational tool to help with wheat management issues. Putting the management recommendations into the hands of crop advisors, professional agronomists and farmers is critical if we are to realize the value of these research investments.
- *Methods:* Research trials will be established to help illustrate the best management recommendations developed from current and past research. Publications will be produced for growers and agronomy professionals to be utilized in their wheat management

Integrated Management of Virus Vectors on Wheat

Principal Investigators: B. Hadi, J. Nixon, and M. Rosenberg

Collaborators: Marie Langham, Plant Virologist,

Bob Fanning and Connie Strunk, Field Specialists in Plant Pathology

Identifying the local “green bridge” of wheat streak mosaic virus (WSMV) and its mite vector to tailor the integrated management of WSMV in South Dakota.

- *Justification/Rationale:* Wheat streak mosaic virus (WSMV) (Family: *Potyviridae*; Genus: *Tritimovirus*), a virus vectored by wheat curl mite (*Aceria tosichella*), is the most common virus infecting wheat in South Dakota. As curative methods to manage WSMV are not available, preventative techniques are the cornerstone of WSMV management. While development of resistant wheat varieties form the first line of defense among the preventative techniques, it is also crucial to identify weak links in the field life cycle of WSMV and its mite vector that can be exploited as a part of integrated approach to manage WSMV. One potential weak link in the virus-vector-host system of WSMV is the period between the harvest and the fall planting of winter wheat. During this period, the mite vector of WSMV is believed to migrate and survive on other locally available plants, the so-called “green bridge.” Elimination of the “green bridge” is seen as an effective method to decrease the risk of fall infection and, eventually, final disease severity. “What constitutes the “green bridge” in South Dakota?” Generically, volunteer wheat growing in the field is believed to constitute the “green bridge,” but preliminary research in Marie Langham’s program provided enough reason to suspect that weeds on field edges play an important role to host mite vector and WSMV during this period. By identifying the local “green bridge” providing refuge for wheat curl mite and WSMV, we expect to tailor effective field recommendations to manage this economically important disease in the unique context of South Dakota.
- *Approach:* Field research will be conducted in commercial wheat fields across the state of South Dakota in 2012 and 2013. The research results will be incorporated into extension publications and other extension delivery methods/events.
- *Methods:* With growers’ collaboration, six fields across the state will be sampled each year. Field specialists in entomology and plant pathology will collect weeds species and volunteer wheat plants from in-fields and field edges of each field every two weeks between June and July. From these samples, the weed species, the mite vector of WSMV and the potential infection of WSMV will be identified and verified. Serological identification of WSMV on the collected samples will be conducted in collaboration with Marie Langham. The same fields will be sampled for WSMV and wheat curl mite in the spring and summer of the following year when the virus and mites have had a chance to migrate back to wheat plants. Through this research plan, the relative importance of in-field and field edges as the local summer source of WSMV infection to winter wheat and the potential importance of different weed species in hosting both the vectors and the viruses can be determined, facilitating precise targeting of “green bridge” management. The information gained from the field research will be communicated in a new extension publication on wheat streak mosaic virus management for South Dakota.

Bridging research results and field recommendation on Barley yellow dwarf virus (BYDV) and its aphid vectors.

Justification/Rationale: After WSMV, BYDV is the second most common viral disease found on wheat in South Dakota. BYDV is vectored by several species of cereal aphids. In the last decade, progress has been made by Marie Langham in collaboration with USDA–ARS Northern Grain Insects Research Laboratory in researching various components of BYDV epidemiology and their impact on wheat yield, but incorporating this new information in to a comprehensive and applied extension publication is yet to be fully executed. Dissemination of academic research results is essential if these results are to come full circle and find their uses in popular agronomic practice.

- *Approach:* In collaboration with Marie Langham and field specialists in plant pathology we are going to develop a series of extension materials on BYDV and its aphid vectors to be communicated publicly as paper copies, through extension meetings, and the iGrow website.
- *Methods:* We will develop a comprehensive extension publication on BYDV. Our group will provide expertise on creating a guide to identify BYDV aphid vectors, their natural enemies and applied commentaries on aphid life cycle and management in context of BYDV epidemiology. Timely recommendations on BYDV and its aphid vectors will be disseminated through extension meetings and the iGrow website.

Plant Pathology Field Specialist Investigators Strunk and Fanning

Educational Wheat Walk Tours

- *Justification/Rationale:* Wheat is a major crop in SD and with input costs constantly on the rise; producers are very interested in maximizing their profits. Wheat diseases are a constantly changing issue that wheat producers have to deal with and many are not familiar with disease identification and management. In addition to diseases, producers are also dealing with changing weed infestations, new herbicide options, dynamic insect problems, and an overwhelming assortment of new fertilizer products that they are being pressured to buy. With fungicides, herbicides and insecticides, producers are also being faced with the threat of pesticide resistance and the resulting loss of these to manage pests.
- *Approach:* Schedule and hold a series of Wheat Walk Tours to inform producers on the newest developments in managing these pests in wheat as well as addressing general agronomic management topics that arise. The Wheat Walk Tours will focus on disease identification and management, but also cover potential weed, insect, and fertility issues, as well as other agronomic management information. The use of crop rotations, cover crops, planting cultivars with disease resistance and other cultural practices will be emphasized. The Wheat Walk Tours will be located in three to four of the major spring and winter wheat growing areas across the state. Extension staff presenting the Wheat Walk Tours would potentially include Plant Pathology, Weed, Entomology and Agronomy Field Specialists.

Conduct a general survey of wheat diseases occurring over a representative portion of South Dakota.

- *Justification/Rationale:* Information is needed on the occurrence of various wheat diseases in South Dakota to help identify both research and educational needs.
- *Approach:* Make periodic visits to selected wheat fields representative of the surrounding wheat growing areas to document wheat diseases that are present in the field and collect samples for proper diagnosis through laboratory analysis. During these field visits, additional efforts may be made to document specific diseases that SDSU Plant Pathology staff may request, and collect samples for research and laboratory analysis.

Identifying the local “green bridge” of WSMV and its mite vector to tailor the integrated WSMV management in South Dakota. (Collaborators: B. Hadi, J. Nixon, and M. Rosenberg)

- *Justification/Rationale:* WSMV management is a necessity for SD wheat farmers. “Green bridging” has an important impact on WSMV’s ability to survive months with no growing wheat and to infect emerging wheat.
- *Approach/Methods:* This objective is for C. Strunk and B. Fanning to participate in the field site sampling and other research on WSMV “green bridges” as collaborators in the previously described research.

Small Grains Pathology

Principal Investigator S. Ali,

Collaborators: J. Gonzales, K. Glover and B. Berzonsky

Research in this proposal includes;

- assessment of leaf spotting pathogens on spring and winter wheat, their proportions in different regions of South Dakota and their characterization for virulence/aggressiveness variation;
- screening of wheat cultivars, germplasm, and wheat relatives for their reaction to multiple fungal and bacterial diseases; and
- participating in the generation of adapted germplasm with novel sources of resistance that can be utilized by the SDSU breeders in the varietal improvement.

Assess leaf spotting pathogens on spring wheat and winter wheat and their proportions in South Dakota and characterization for their variability in their race structure/aggressiveness.

- *Justification/Rationale:* Wheat is attacked by various leaf spotting fungal and bacterial diseases that can cause millions of dollar losses to wheat producers by affecting wheat quality and quantity. The pathogen (s) population (s) that cause these diseases may vary from one part of the state to another depending on the cultivar susceptibility, weather conditions, and disease management strategies used. Based on general observations, *Pyrenophora tritici-repentis* (tan spot), *Stagonospora nodorum* (*S. nodorum* leaf blotch), *Stagonospora avenaria* (*S. avenaria* leaf spot), *Septoria tritici* (*S. tritici* leaf blotch), *Choctliobolus sativus* (spot blotch), and Bacterial leaf streak (*Xanthomonas translucens pv.undulosa*) are commonly observed on wheat in the region.

Of these pathogens, *S. avenaria*, *S. nodorum* and *C. sativus* not only attack wheat but also damage barley, another important cereal crop in the state. Leaf spot diseases of wheat can be managed through various approaches, such as use of resistant cultivars, fungicide application, crop rotation with non-cereals, and residue management. However, use of resistant cultivars and fungicide application seem to be the most promising strategies, as cultural practices such as crop rotation and burying crop residue are not practicable under some conditions. Knowledge of leaf spot pathogens prevalent on wheat in the region and their physiological variation within a pathogen population are very crucial in the development of resistant cultivars and other disease management strategies.

Therefore, it is necessary to monitor leaf spotting pathogens populations periodically to see if any changes have occurred in the fields. Multiple races of *P. tritici-repentis* have been identified. These races produce host-selective toxins which are associated with disease development. Race 1 is the most prevalent race worldwide. Of these Races, 3 and 5, previously reported from Canada and North Africa, respectively, were observed on durum and spring wheat in North Dakota. Most of the spring wheat cultivars grown in this region are susceptible to Race 5. Our research group has also recently isolated multiple host-selective toxins from *S. nodorum*, another important leaf spot pathogen of wheat found to be associated with pathogenicity or virulence of the pathogen. Recently *S. avenaria* has re-emerged as a predominant pathogen on wheat in eastern North Dakota.

Information on the variability among and within the leaf spotting pathogens of wheat prevalent in different regions of South Dakota will help pathologists and breeders in developing durable resistance wheat cultivars and other disease management strategies to reduce the disease impact on wheat production which would ultimately bring more revenue to the South Dakota wheat community.

- *Approach:* Samples of diseased leaves with leaf spots of spring wheat and winter wheat will be collected from SDSU experiment research centers and commercial fields across the state during the growing season of 2012 and 2013. Leaf spot pathogen (s) isolates from the samples will be recovered and characterized for their race structure and/or aggressiveness variation on standardized wheat differentials. Molecular techniques will also be used for confirming the identity of *P. tritici-repentis* races. Similar approaches will be used in characterizing other recovered leaf spot pathogens.

Evaluation of wheat cultivars/germplasm, and wheat relatives for their reaction to multiple fungal diseases and bacterial leaf streak.

- *Justification/Rationale:* Knowledge of disease resistance level in currently available cultivars/germplasm and sources of resistance with diverse genetic backgrounds to a particular pathogen are very crucial in the development of resistant cultivars and other disease management strategies. A majority of the pathogens causing wheat diseases such as tan spot, Stagnospora leaf blotch, common root rot and spot blotch, and Fusarium head blight survive on crop residue which is mostly available year around due to no-till or minimum tillage practices. Additionally, cultivation of both winter wheat and spring wheat in the state could serve as a “green bridge” between the two growing seasons providing an opportunity for thriving biotrophic pathogens such as causing leaf rust and stripe rust. Due to the presence of multiple pathogens year around in the region, any given wheat field can be attacked with multiple diseases, depending on the cultivar used and suitable conditions for disease development. Information on germplasm reaction to multiple diseases would help the breeders and growers in making decision in choosing suitable disease management strategy (s).
- *Approach:* Spring and winter wheat nurseries comprising of varieties and breeding materials will be evaluated for multiple diseases during the growing seasons 2012 and 2013. Some of the nurseries may be located in other states such as FHB nursery in Arizona and stem rust nursery in Texas, and will be performed in collaboration with the breeding projects. Disease severity for the pathogen (s) on select lines will be noted and pathogen (s) isolates will be recovered for testing and future use. Rust samples will be collected from various breeding nurseries and submitted to USDA-ARS Cereal Disease Laboratory, St. Paul, MN for race typing. Breeding material will be screened for individual disease during the fall and winter, with an emphasis on the rusts, tan spot, and bacterial blight.

Participate in the generation of adapted germplasm with novel sources of resistance that can be used by the SDSU wheat breeders in their varietal improvement efforts.

- *Justification/Rationale:* Breeding for resistance or tolerance to plant pathogens is one of the most effective ways to reduce crop losses due to disease. Unfortunately plant pathogens can move to a new region and/or adapt to the resistance traits deployed in modern wheat varieties. This results in the reemergence of pathogens, which can result in significant losses to growers. For example, wheat leaf rust is constantly changing and adapting to the Lr genes present in the commonly grown varieties that were once resistant. Other pathogens are never fully controlled by genetic resistance and therefore a need exists to combine multiple sources of resistance into one variety. For example, the ‘Sumai3’ FHB resistance traits have had a very positive impact in the region’s spring wheat crop, however losses can still occur under intensive epidemic pressures and varieties with even higher levels of resistance are required.
- *Approach:* This project is essentially a pre-breeding effort where wheat lines with novel and under-utilized sources of genetic resistance for different diseases will be crossed with regionally adapted germplasm. This material will then be assessed for disease resistance in the greenhouse and/or field, and may be back-crossed or top-crossed further with adapted lines. Following selection, lines will eventually

be added into the spring and winter wheat breeding programs. Target traits will include resistance to Ug99 stem rust, wheat leaf rust, FHB, and common root rot.

Virology

Principal Investigator - M. Langham

Evaluating winter wheat lines in the AYT-CPT nurseries for their performance when infected with wheat streak mosaic virus (WSMV) (Collaborator: William Berzonsky, Winter Wheat Breeder)

- *Justification/Rationale:* Studies have shown that winter wheat losses due to WSMV range from 2.5-5 million bushels annually with greater losses than this occurring in epidemic years. Control of viral diseases depends on the development of preventative disease management strategies. The most effective and economical of these strategies is the development and deployment of host plant resistance or tolerance. Efforts to develop winter wheat cultivars with higher levels of disease resistance and tolerance require the evaluation of plant materials to determine their susceptibility or resistance. Collaborative efforts of the plant virology and winter wheat breeding projects have resulted in recently released varieties and breeding lines with improved tolerance. However, the development of wheat cultivars requires annual evaluation. Without this continuous process, susceptible materials may not be eliminated from the breeding program, and previous advances in resistance and tolerance may be lost.
- *Approach:* There are two basic portions of this objective:
 - Completing data collection and evaluation for 2011-2012 WSMV Winter Wheat Nursery—Inoculated in Fall 2011, this nursery will need to be evaluated for disease severity, stunting, maturity delays, yield losses, and losses in test weight during Spring and Summer 2012.
 - Initiating and inoculating the 2012-2013 WSMV Winter Wheat Nursery—During Summer 2012, WSMV infected plants will be grown and frozen for making inoculum. The nursery will be planted (Winter Wheat Breeding) and inoculated (Virology) during Fall 2012.
- *Methods:* Winter wheat lines will be planted in four row plots in three replications, and half the plot will be inoculated using a high-pressure (80 psi) air compressor. Plants will be inoculated with sap extract [1:10 infected plant tissue and potassium phosphate buffer (KPB), pH 7.0] and 1 percent of silicon carbide powder (600 mesh) added. Plants will be rated through the spring for symptom development and severity. Data will be collected on the agronomic characters of each plot half to determine the effects of WSMV. All loss figures are calculated using the difference between the control and inoculated halves of the split plot in order to reduce the variability as much as possible.

Developing winter wheat varieties with resistance to pests and pathogens emerging as significant threats to SD production. (Collaborators: William Berzonsky, Buyung Hadi, and Jose Gonzalez)

- *Justification/Rationale:* WSMV and BYDV are the two most important viral diseases of wheat in South Dakota causing significant yield losses. This objective is to provide for collaboration with this project to develop varietal resistances by pyramiding genes for pathogens and pests.
- *Approach/Methods:* Developed materials will require evaluation for their resistance to WSMV. Detection of viruses in developed material will be done by DAS-ELISA or other appropriate serological techniques. As this project progresses over the four year duration, the amount of material that needs to be evaluated will increase. Thus, the amount of evaluation will expand in upcoming years.

Identifying the local “green bridge” of WSMV and its mite vector to tailor the integrated WSMV management in South Dakota. (Collaborators: B. Hadi, J. Nixon, and M. Rosenberg)

- *Justification/Rationale:* The importance of alternate hosts for WSMV should never be underestimated in the management of WSMV. The “green bridges” for both the virus and vector establish the continuum of WSMV in the disease cycle. Variations in the wheat curl mites and their “green bridging” roles have become increasingly apparent in recent years (Stephen Wegulo, NE; personal communication). Thus, this objective is to collaborate with the “green bridging” of WSMV and its vector that was discussed above.

- *Approach /Methods:* Collected weed and wheat field samples will require serological detection to evaluate their role in WSMV bridging. WSMV be detected by DAS-ELISA or other appropriate serological techniques.

Joint Deliverables:

- Educational materials for stakeholders:
 - Bacterial Leaf Streak,
 - Wheat Streak Mosaic Virus and the Wheat Curl Mite,
 - Barley Yellow Dwarf Virus and its Aphid Vectors ,
 - Common Root Rots.
- Quarterly meetings of the South Dakota Plant Pathology Working Group addressing soybean and other diseases.
- Enhanced coordination of wheat research and outreach projects.
- Enhanced ability to identify outreach needs.
- Enhanced interaction between researchers and field specialists.

Extension Plant Pathology Field Research Deliverables (Ruden):

- Information on investigation of fungicides relative to wheat in SD.
- Disease management efficacy results published in print and online each year.
- SDSU CES Publications FS917- Managing Crop Diseases with Fungicides, FS949- Managing Crop Diseases with Seed Treatments and FS952 – South Dakota Wheat Fungicide Management. Recommendations will be updated using the information that has been generated.
- Information will be presented at field days, crop clinics and grower meetings across the state.

Integrated Management of Virus Vectors on Wheat Deliverables (Hadi, Nixon, Rosenberg):

- Identification of the local “green bridge” of WSMV and its mite vector to tailor the integrated WSMV management in South Dakota.
- New extension publications and timely extension update on the iGrow website and radio on WSMV and BYDV management in South Dakota.

Plant Pathology Field Specialist Deliverables (Strunk, Fanning):

- Provide an opportunity through the Wheat Walk Tours for producers to receive information on identifying and managing various wheat diseases, weeds, and insects and other agronomic information. The benefits of crop rotations, cover crops, and using resistant varieties will be stressed. These Wheat Walk Tours will allow producers to interact with Plant Pathology, Weed, Entomology and Agronomy Field Specialists, discuss their concerns and get their questions answered in person. Material will be provided to attendees for future reference.
- Assemble better information quantifying and qualifying the extent of existing wheat diseases in South Dakota. Results will be compiled and made available.
- Update existing factsheets with new information and create a new publication on wheat diseases.

Small Grains Pathology Deliverables (Ali)

- Provide complete inventory of leaf spot pathogens and their proportions prevalent on wheat in South Dakota and information on genetic variability for virulence and/or aggressiveness which would ultimately help in developing durable disease resistance cultivars and other disease management strategies.
- Enhance understanding of bacterial leaf streak (BLS) and fungal diseases resistance/susceptibility of winter wheat and spring wheat utilized in SD. This will include both commercially grown cultivars and germplasm.

- Generate wheat lines and breeding populations with enhanced resistance (by pyramiding genes or using diverse sources of resistance) to multiple fungal diseases. These will eventually be used in breeding program and for un-locking the genetic mechanism of resistance at molecular level (this will be achieved with the collaborated efforts of SDSU breeders and geneticists).

Virology Deliverables (Langham):

- Rating and harvest of the 2012 WSMV Winter Wheat Nursery including yield losses, test weight losses, stunting and delay in maturity.
- Planting and inoculation of the 2013 WSMV Winter Wheat Nursery.
- Current information on the performance of wheat lines when inoculated with WSMV.
- Collaboration with developing winter wheat varieties with resistance to pests and pathogens emerging as significant threats to SD production.
- Collaboration with identifying the local “green bridge” of WSMV and its mite vector to tailor the integrated WSMV management in South Dakota.
- Poster exhibitions at regional or national plant pathology meetings.
- Publication in appropriate scientific outlets.