Wheat Diseases and Vectors: Integrated Management, Diagnostics, & Germplasm Evaluation

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Reporting period: July 1, 2012 – August 29, 2013

Total project period: This grant was an integrated project with components that included both annual and continuing objectives.

Report type: Final report—This is the final report for the integrated plant pathology grant. The projects that have annual project objectives continued these as separate grants.

Research Summary (Overview)**:** This proposal represents the combined research and outreach on wheat diseases and vectors of the South Dakota Pathology Group and included both collaborative and individual projects. It addressed diseases that impact wheat yields, production and the sustainability of South Dakota wheat producers. It allowed the scientists to focus their expertise on individual problems in their major areas of emphasis, and also to pool their expertise for collaboration on specific wheat disease and management issues. Objectives in this proposal included topics on Stakeholder Education and Outreach, Development and Evaluation of Wheat Germplasm for Disease Resistance, and Management, Identification, and Characterization of Plant Diseases and their Vectors as detailed below:

Objectives (Summarized)

Stakeholder Education and Outreach

- Pathogen, vector, and disease based Extension materials
- Meetings of the South Dakota Plant Pathology Working Group
- Educational Wheat Walks for stakeholders

Development and Evaluation of Wheat Germplasm for Disease Resistance

- Evaluate AYT-CPT winter wheat lines performance when infected with WSMV
- Germplasm evaluation 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
- Characterization of leaf spotting fungal pathogens

Note: Each subsection or component of the grant has a separate summary, introduction, and accomplishments. Publications/data brings the group back together and represents that we have all contributed to each other's work in many ways.

Joint Objectives (Entire Group)

Research Summary: This component of the grant was a mechanism to foster collaboration and interaction between the professors, field specialists, and staff working in plant pathology through enhanced meetings, publications, outreach and research.

Introduction: The objectives of this goal were as follows:

1. **Development of educational materials for stakeholders and other agricultural professionals** --Education is one of the strongest tools in providing the stakeholders with the knowledge needed to identify and manage diseases in their wheat production. The South Dakota Plant Pathology Working Group has worked together to develop many educational materials for the wheat stakeholders in South Dakota. These can be seen in the publications section (I have not listed them for the sake of redundancy.)
2. **Continuing wheat disease research and disease management outreach for South Dakota stakeholders**--South Dakota stakeholders need the delivery of research-based information generated by the scientific research accomplished by individuals and teams to provide the most current understanding and management recommendations. The Plant Pathologists formed the South Dakota Plant Pathology Working Group 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 promoted the flow of research information to extension personnel and provided research personnel with access to the most current developments in the producer's fields. Meetings promoted development of research on emergent wheat diseases. Publications on wheat diseases were facilitated.

Description of Accomplishments: The accomplishments of this objective are principally summarized in the Publications section and in some of the Components highlighting their connections with this component. Thus, these are not repeated in this section to limit the redundancy of material, but this objective is the master objective for educational materials developed during this grant. Publications associated with the topics researched in this grant during this year include 5 scientific publications, 28 stakeholder publications, numerous stakeholder meetings, radio and other press interviews, and direct consultations with wheat producers around the state.

Extension Plant Pathology Field Research (Kay Ruden and Emmanuel Byamukama)

Research Summary: Successful management of foliar, heading and seedling diseases through the use of fungicidal seed treatments and post-emergence fungicides remains a key component of disease management plans for producers. Research trials, partially funded through the current proposal, have been successful in demonstrating to producers, crop consultants, etc. the difference in fungicide product efficacy. More importantly, in general, fungicides were demonstrated to be a very successful tool for suppression of seedling and leaf diseases and Fusarium Head Blight (FHB) when there is a potential for disease to develop in the crop and that fungicide use can provide positive returns on producers' investments.

Introduction: Assessment of fungicidal management strategies for fungal wheat diseases and dissemination of educational tools detailing these assessments was the focus of Extension Plant Pathology field research. Its objectives are detailed below:

Objective 1: Development and evaluation of chemical and integrated disease management strategies.

- Wheat diseases caused by fungi can be managed through many methods, including seed treatments, foliar fungicides and cultural methods.
- The combination of favorable environments, 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 development on the South Dakota wheat crop. Accordingly, the potential for plant health 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 hinge on fungicide application when it is integrated with varietal resistance, cultural practices and disease risk assessment. An important part of determining the most effective strategies for managing FHB and mycotoxins was the testing a group of fungicides and biological control agents at different timings in winter and spring wheat accomplished in this research.

Objective 2: Develop and deliver educational tools to help with targeting critical wheat pest management issues through research trials, publications and programming.

- The research-based information generated through field plots trials was disseminated to South Dakota growers and to the allied industries. Extension bulletins were 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.

Description of Accomplishments: The accomplishments of Extension Pathology Field Research are summarized below:

Seed treatments (2012 and 2013 growing seasons):

- Many different current, "up and coming" and experimental fungicide seed treatments were tested to determine their effectiveness in our environment in South Dakota.
- Due to low disease pressure at the trial locations, differences between seed treatments were minimal and largely non-significant.
- We have provided the data to the chemical companies, and they in turn have been able to use the data to support new product registrations in the state. Registration of newer seed treatment products give our producers more options to consider for root disease control.

Foliar fungicides for leaf and scab diseases:

- In the 2012 growing season, stripe rust made an appearance. Our data in the winter wheat trials reflects that the flag leaf timing reduced stripe rust in the susceptible varieties. In the spring wheat trials, our data shows that the flag leaf timing and heading to flowering time applications reduced stripe rust in susceptible varieties. Greater returns to the fungicide investment would be expected in lines that show lower resistance levels.
- In 2012, Fusarium head blight was at low levels in our winter wheat and spring wheat trials. The trials also had low DON levels. No significance was observed for of products or timings in our trials due to the low levels of Fusarium head blight. Dealing with Fusarium head blight for over 20 years, we have seen many ups and downs when doing trials and evaluating the fungicides to help with control of scab.
- In the 2013 growing season, leaf rust was observed in our plots but at low levels. It moved into South Dakota late in the season this year. Since it was at such low levels, there were no significant fungicide treatment effects this year.
- For the Fusarium head blight trials in 2013, we saw some significant treatments (Prosaro, Caramba, Tebucon, Tebucon + Caramba, Tebucon + Thymol applied at the Feekes 10.51 growth stage plus Prosaro and Caramba applied at 3-7 days after Feekes 10.51) at the Groton location where all of these treatments reduced FHB Disease Index. At the NE Farm location, no significant effect of the treatments for FHB Incidence, FHB Severity or FHB Disease Index was found. At the Volga location, all treatments except for the Tebucon treatment, significantly reduced FHB Incidence. Only the Caramba applied at Feekes 10.51 and Caramba applied at 3-7 days after Feekes 10.51 reduced FHB severity. All of the treatments except for the Tebucon treatment were significant in reducing the FHB Disease Index.

Projections: Our proposed research and trials have met the objectives that were outlined in the proposal. With cooperation from other collaborators, we accomplished this research and have provided (and will continue to provide) the results to the public.

Integrated Management of Virus Vectors on Wheat (B. Hadi, M. Rosenberg, B. Fanning, M. Langham)

Research Summary: *Wheat streak mosaic virus* (WSMV) (Family: *Potyviridae*; Genus: *Tritimovirus*), a virus vectored by wheat curl mites (*Aceria tosichella*), is the most common virus infecting wheat in South Dakota. We proposed to identify the alternative hosts of WSMV and wheat curl mites that serve as green bridges for the virus and vector to survive the period where wheat is not available. The rationale is that if the green bridge for the virus and vector can be identified, it constitutes a weak link in the disease epidemiology to be exploited for the management of wheat streak mosaic. To identify the alternative hosts, we identified four fields in south central South Dakota with recent WSMV history, and we sampled the weeds growing in and around the fields for WSMV and wheat curl mites. Sampling was conducted five times in the fall and spring. One hundred and sixty one weeds and sorghum samples were collected in 2012-2013. We found very low number of wheat curl mite in the gathered samples. All mites were collected from sorghum. The range of plants from which WSMV was identified was broader, including sorghum, volunteer wheat, smooth bromegrass and quackgrass.

Introduction: 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 the disease. One potential weak link in the virus-vector-host system of WSMV is the period between wheat harvest and the fall planting. 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. The question is thus: "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 by 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. We proposed to identify the alternative hosts of WSMV and wheat curl mites that serve as green bridges for the virus and vector to survive the period where wheat is not available. By identifying the local 'green bridge' providing refuge for wheat curl mite and WSMV, we expected to tailor effective field recommendations to manage this economically important disease in the unique context of South Dakota.

Description of Accomplishments: Five wheat fields in south central part of the state (around Winner) with recent WSMV history were identified. Samples of weeds growing on the edge and within fields were collected five times between September of 2012 and June of 2013. In one case, sorghum plot planted adjacent to a wheat field with WSMV history was sampled in September of 2012.

- A total of 161 samples were collected. The most frequently collected weeds were smooth bromegrass, quackgrass and volunteer wheat. The weeds species were distributed evenly between the edge and the inner side of the field. Field identification and sample collection were conducted by Robert Fanning and Buyung Hadi. Weed identification was conducted by Mark Rosenberg.

- In all samples, only eight wheat curl mites were detected and identified. All of these mites were collected from the sorghum plot planted adjacent to a wheat field. Wheat curl mite detection and identification were conducted by Buyung Hadi.
- Not all samples have been processed for WSMV detection. Among the processed samples, WSMV was detected more often than wheat curl mite on a broader range of weeds/plants growing adjacent to wheat fields. The hosts in which WSMV were detected include volunteer wheat, smooth bromegrass, quackgrass and sorghum. WSMV detection was conducted by Marie Langham.

Projections: For 2013-2014 period, we planned to repeat the methodology assumed in 2012-2013 and to develop extension publications (online and print) summarizing our finding and the current state of knowledge on WSMV management for South Dakota. The greatest hurdle in 2013-2014 is the noted absence of WSMV in 2013 around our sampling region. None of the fields sampled in 2012-2013 showed WSMV infection. We have not been able to identify more fields with recent WSMV history through extension channels. Thus far, we have sampled a pasture field with noted WSMV infection and found both the mite and the virus. In spring 2014, we will continue to search for fields with recent WSMV history to be sampled. Development of the extension materials on WSMV management has been initiated and should be completed by the end of the current funding period.

Plant Pathology Field Specialists (C. Strunk and B. Fanning)

Research Summary: Wheat disease education was made available to producers through private applicator trainings, commercial applicator trainings, crops clinics, Wheat Walks, SDSU IPM Field School, iGrow articles and iGrow Radio spots, and other educational materials as handouts. Assistance was provided to the WSMV "Identification of the Green Bridge" project, headed by B. Hadi, in identifying locations from which to collect samples, and the collection of the samples. Plots were also established and maintained for the "Wheat Health Management" project, in which various levels, sources, application methods and rates of chloride are being explored with the intent of maintaining wheat health, better managing root diseases and minimizing the need for foliar fungicides.

Introduction: The objectives of this portion of the grant are stated below:

- The Wheat Walk Tours provided an opportunity 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 were stressed. The Wheat Walks allowed producers to interact with Plant Pathology, Weed, Entomology and Agronomy Field Specialists and/or State Specialists, discuss their concerns and get their questions answered in person. Material was provided to attendees for further reference.
- Assist with general surveys of wheat diseases occurring over a representative portion of South Dakota in conjunction with other researchers. Information is needed on the occurrence of various wheat diseases in South Dakota to help justify both research and educational efforts. Periodic visits to wheat fields were made to document wheat

diseases that are present in the field and collect samples for proper diagnosis through laboratory analysis.
- An existing factsheet was updated while plans are in progress for creating a new pictorial guide for wheat diseases.

Description of Accomplishments: "Wheat Walks" were held at four locations, with approximately 100 producers in attendance. Each of the major topic areas of wheat production were represented, including: agronomy, entomology, soil fertility, plant pathology, and weed control. Also present were representatives of the SD Wheat Commission and SD Wheat Inc. A specialist from each area gave a brief presentation on the major issues regarding wheat production in their topic area, and time was allowed for producers to interact with the specialists and ask questions. Sponsorships were secured from area agribusinesses to assist with travel expenses, refreshments and publication costs, removing the need to charge producers to attend. Research results from the WSMV Green Bridge project will be reported by B. Hadi. The Wheat Health Management project indicated minimal yield responses to applied chloride fertilizer, but significant increases in chloride levels in plant tissue.

Projections: The Wheat Walks provided an excellent opportunity for producers to get updated research based information and interact directly with SDSU Extension Specialists. These efforts are planned to continue. The Wheat Health Management project is also planned to be continued in hopes of evaluating the effectiveness in managing root and crown diseases with chloride fertility.

Small Grains Pathology (S. Ali)

Research Summary: Research in the Small Grains Pathology section of this grant can be summarized in the following accomplishments:

- Based on leaf disease survey, tan spot and spot blotch are the most prevalent leaf diseases in the region. The fungal pathogens recovered from the collected leaves samples are being investigation for their race/aggressiveness.
- We have tested some commercial wheat cultivars and germplasm for their reaction to leaf diseases and found most of them susceptible to leaf spot diseases.
- Fifteen hundred wheat genotypes with diverse genetic background were tested for their reaction to tan spot race1 and 153 exhibited high resistance to the disease. These resistance lines are being investigated for SNB and BLS. Wheat genotypes exhibit resistance to multiple diseases will be shared with SDSU wheat breeders to include in their breeding programs as sources of resistance.

Introduction: Research in this proposal includes assessment of leaf spotting pathogens on spring and winter wheat; their prevalence and population 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 participation in the generation of adapted germplasm with novel sources of resistance that can be utilized by the SDSU breeders in the varietal improvement. The Small Grains Pathology portion of this grant addressed the following objectives:

Objective 1. 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.

Objective 2._Evaluation of wheat cultivars/germplasm, and wheat relatives for their reaction to multiple fungal diseases and bacterial leaf streak.

Objective 3. 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.

Description of Accomplishments: The accomplishments and progress of this grant unit include the following:

Objective 1. 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. In 2012 and 2013, 110 diseased leaf samples were collected from across the state. All collected leaf samples were cut into small segments (~2 cm long) and stored in the refrigerator until used for isolation. To recover the leaf spotting fungal pathogens, 40-50 leaf segments of each sample were plated on three layers of dampened Whatman filter paper. The plates were exposed to 24 hours light at room temperature and 24 hours dark at 16°C in the incubator to induce *Pyrenophora tritici-repentis* conidiophores and conidia, respectively. The incubated leaf segments were examined under dissecting microscope for leaf spotting pathogens. The spores of any pathogen(s) associated with the segments were picked-off with a flamed sterile steel needle and transferred them individually on V8-PDA plates. The recovered isolates were stored at -20°C. *P.tritici-repentis* (Tan spot), *Stagonospora nodorum* (Stagnospora nodorum leaf blotch), *S. avenea* (Stagonospora avenea leaf blotch), *Bipolaris sorokiniana* (spot blotch), and *Colletotricum graminicola* were recovered in various proportions from the analyzed samples. *P. tritici-repentis* and *Stagnospora avenea* were the most and least prevalent pathogens recovered (respectively) from the analyzed leaves samples. Based on the leaf samples analyzed, tan spot and spot blotch seem to be the most prevalent diseases in the state. We recovered and stored 253, 63, 19, and 19, isolates of *P. tritici-repentis, B. sorokiniana, S. nodorum,* and *S. avenea*, respectively, from the collected leaf samples. The fungal isolates still need to be analyzed for their race structure and/or aggressiveness variation. Forty leaf samples still need to be analyzed for leaf spotting fungal pathogens. The research work in the 2012-2013 submitted proposal was planned for two years. Due to lack of funding for the 2nd year of the project, we could not complete this objective. We hope to receive some funding during the next funding cycle to accomplish this proposed objective.

Objective 2. Evaluation of wheat cultivars/germplasm, and wheat relatives for their reaction to multiple fungal diseases and bacterial leaf streak.--In the 2012 and 2013 wheat growing seasons, we evaluated AYT, PYT, and PPY hard red spring wheat trials for leaf spots, leaf rust, stripe rust located at Aurora, Watertown, and Groton. Disease data was compiled and provided to Dr. Glover. We also evaluated winter wheat AYT, PYT, PPY, and other breeding experiments at Aurora in both years, and the disease data was given to Dr. Berzonsky. In March 2013, Small Grains Pathologist (Dr. Ali) traveled with Dr. Berzonsky to San Antonio, Texas and evaluated the winter wheat leaf rust nursery. Small Grains Pathology lab evaluated both winter wheat and spring wheat germplasm (170 lines) for their reaction individually to tan spot, Stagnospora leaf blotch, leaf rust and stem rust at seedling stage in the greenhouse and provided disease data to the respective breeder. The lab also tested 47 wheat cultivars/genotypes for their reaction to tan spot, SNB, leaf rust, and bacterial leaf streak and shared this data with Dr. Nathan Mueller (SDSU Agronomist) to include in extension bulletins providing information to the state wheat community.

Objective 3. 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.--Fifteen hundred wheat genotypes with diverse genetic background received from CIMMYT, Mexico were screened for their reaction to tan spot with race 1. One hundred and fifty-three genotypes showed high level of resistance to tan spot. These resistance genotypes will also be screened for Stagnospora leaf blotch and spot blotch. Wheat genotypes that exhibit resistance to multiple leaf diseases will be utilized as sources of resistance in SDSU wheat breeding programs.

Projections: It will take more than the two years originally proposed to achieve all the goals suggested in the proposed objectives due to reduced level of available funding.

Virology (M. Langham)

Introduction: *Wheat streak mosaic virus* (WSMV) (Family: *Potyviridae*; Genus: *Tritimovirus*) causes the most economically important viral disease affecting winter wheat in South Dakota. 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 process, susceptible materials will not be eliminated from the breeding program, and previous advances in resistance and tolerance will be lost.

Description of Accomplishments: There were two basic objectives for this portion of the grant as seen below:

Objective 1 Data collection and evaluation of the 2012 WSMV Winter Wheat Nursery—The primary focus of this objective was to complete data collection and evaluation for the 2011-2012 WSMV Winter Wheat Nursery. This nursery was inoculated in Fall 2011 (as a part of the previous grant), and it was evaluated for disease severity, stunting, maturity delays, yield losses, and losses in test weight during Spring and Summer 2012. In 2012, sixty-six winter wheat lines from the All Yield Trials (AYT) and Crop Performance Trials (CPT) were selected for the 2012 WSMV Winter Wheat Evaluation Nursery (Tables 1 and 2). Plants were evaluated for disease severity, agronomic characters, and yield losses. In assessing the values for wheat lines in this nursery, it should be noted that an early snow and late germination forced this nursery to be inoculated in the spring rather than the fall, and in previous research, evaluation markers have shown significant differences when comparing pre and post vernalization inoculation. Disease severity was rated on the following scale:

Rating	Description of Symptoms
0	No visible symptoms
1	Very mild symptoms; Isolated small light green areas of mosaic; No stunting
2	Mild symptoms; Small areas of light green or yellow mosaic; Short streaks in length; Mild stunting
3	Moderate symptoms; Areas of predominately yellow mosaic; Coalescence of isolated areas into streaks extending most of the leaf length; Moderate stunting
4	Severe symptoms (Fig. 1); Severe mosaic with yellowing covering the majority of the leaf; Some very small areas of necrosis; Severe stunting
5	Very severe symptoms; Extreme yellowing; Necrosis; Very severe stunting; Some plants exhibit death of leaves or the entire plant

Clearly intermediate reactions were rated in categories between the major categories (1.5, 2.5, 3.5, 4.5). Disease severity ratings (DSR) were significantly affected by WSMV (Chi square < 0.0001). Both the mean and mode for the DSR are shown in Table 1 with the lowest DSR values being shown by the lines Mace and Hawken. Early season mosaic reactions can be seen as a plot (Fig. 1) and in an individual leaf (Fig. 2). Typically, the DSR become more severe as the season progresses. WSMV caused significant yield losses (p<0.0001) and test weight losses (p<0.0001) in the tested wheat lines. Wheat lines with the lowest yield losses include Vista (14.1%), Hawken (16.4%), Everest (17.2%), SD10123 (17.2%), Jerry (17.5%), SD07W083-7 (18%), Mace (25.5%), SD09140 (26.7%), WB-Matlock (27.3%), and Fuller (27.38%). The most severely affected wheat lines displayed yield losses in the 60-70% range. This included TAM 107 (62.8%), SD09192 (62.9%), SD08141 (64.3%), SD09117 (65.1%), Settler CL (66%), SD10020-1 (66%), SD10W153 (66.51), Wesley (68.8%), Expedition (69.1%), SD09211 (69.3%), IDEAL (75.9%), SD10097-1 (76%) and Jagalene CK (76.5%).

Objective 2 Planting and inoculation of the 2013 WSMV Winter Wheat Nursery—This objective centers on preparing and inoculating the 2012-2013 WSMV Winter Wheat Nursery. During the summer of 2012, 100 kg of WSMV infected Arapahoe winter wheat was grown in the greenhouse in batches of approximately 100 terraboxes. Each batch was tested by ELISA to insure high virus titers in the wheat. Plant tissue was collected, chopped into one inch pieces, vacuum sealed in plastic bags in 250 g aliquots, and frozen until use. Tissue needs to be less than 4 months old when used or the virus titer will have decreased. The sixty-nine lines in the 2013 WSMV Winter Nursery (Alice, Arapahoe, Art, Camelot, Dawn, Everest, Expedition, Fuller, Ideal, Jagalene, Jerry, LCH08-80, LCS Mint, Lyman, Mace, McGill, Millennium, NE06545, NI08708, Overland, Robidoux, RonL, Sage, SD06158, SD07165, SD07184, SD08080, SD08141, SD08200, SD09113, SD09118, SD09138, SD09140, SD09192, SD09227, SD10015-2, SD10020-2, SD10026-2, SD10027-2, SD10048, SD10066, SD10109-2, SD10135, SD10215-1, SD10257-2, SD10W006-1, SD10W153, SD110036-2, SD110038-3, SD110039-2, SD110044-7, SD11005-5, SD110060-10, SD110060-9, SD11009-5, SD11020-1,SETTLER CL, Smoky Hill, SY-Wolf, T158, T163, TAM 107, Tomahawk, WB Cedar, WB-Grainfield, WB-Matlock, WB-Redhawk, Wesley, Vista) were planted during September, 2012. However, the lack of moisture at this time resulted in only very sparse germination. Inoculation had to be postponed until spring. The expiration date on the inoculum produced during the summer had passed, and new inoculum had to be produced during the late winter and early spring. Inoculation took place in the spring, and while this does not emulate fall infection, it does model spring inoculation. Inoculum was made by macerating a 1:10 (w:v infected tissue:0.02M potassium phosphate buffer, pH 7.0) with 1% of silica carbide powder added to the strained liquid. Approximately, 70 gallons of inoculum were sprayed onto the inoculated half plots at the rate of 25 ml/row ft at 100 psi.

Projections: The information obtained in this research is being shared with breeders and other stakeholders. Requests for funding will continue on an individual basis so that this nursery can continue to be evaluated. When selecting for resistance, active resistance selection is required and without it, susceptible materials are not eliminated from consideration for release and as breeding parents.

Publications/Data (Representing Entire Group):

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Table 1. Disease Severity Ratings for 2011-2012 Wheat Streak Mosaic Virus Winter Wheat Evaluation Nursery (DSR ratings are described in the text.)

Wheat Line	Mean	Standard deviation (sd)	Mode
ALICE	3.8	0.45	4
ARAPAHOE	3.4	0.3	3.5
ART	3.3	0.36	3.5
CAMELOT	2.7	0.61	2.5
DAWN	3.4	0.46	3.5
EVEREST	2.9	0.39	3
EXPEDITION	3.8	0.36	3.5
FULLER	3.0	0.35	3
HAWKEN	1.9	0.63	1.5
HV9W05-1125R	2.8	0.25	3
HV9W06-722	2.7	0.62	3
IDEAL	3.5	0.79	3
JAGALENE CK	3.5	0.43	3
JERRY	2.8	0.57	3
LYMAN	3.8	0.26	4
MACE	1.6	0.49	1.5
MCGILL	3.0	0.35	3
MILLENNIUM	2.8	0.71	3.5
OVERLAND	2.9	0.61	3
ROBIDOUX	2.8	0.45	3

Table 1. Continued			
Line	Mean	Standard deviation (sd)	Mode
SAGE	3.1	0.69	2.5
SD05085-1	3.2	0.36	3.5
SD06158	3.6	0.41	4
SD07184	3.1	0.65	3.5
SD07W083-4	3.1	0.41	3.5
SD07W083-7	2.9	0.42	3
SD08080	3.3	0.56	3.5
SD08141	3.4	0.53	3.5
SD08196	3.6	0.33	3.5
SD08200	3.4	0.46	3.5
SD09034	3.4	0.17	3.5
SD09113	3.9	0.49	4
SD09117	3.4	0.30	3.5
SD09118	2.8	0.61	3
SD09138	3.4	0.49	3.5
SD09140	2.8	0.71	2.5
SD09161	2.4	0.49	2.5
SD09192	3.7	0.44	3.5
SD09211	3.7	0.51	3.5
SD09227	3.4	0.65	3.4
SD10015-2	3.8	0.61	4
SD10020-1	3.6	0.46	3.5

Table 1. Continued			
Line	Mean	Standard deviation (sd)	Mode
SD10020-2	2.6	0.42	3
SD10026-2	3.0	0.71	3.5
SD10026-4	2.7	0.44	2.5
SD10027-2	3.0	0.35	3
SD10048	2.7	0.79	2.5
SD10066	2.9	0.7	2
SD10097-1	3.9	0.39	4
SD10109-2	3.1	0.65	3.5
SD10123	2.8	0.71	3
SD10135	2.6	0.58	2
SD10215-1	3.3	0.43	3.5
SD10216	3.9	0.30	4
SD10257-2	2.9	0.52	3
SD10W003	2.8	0.51	3
SD10W006-1	2.9	0.58	3
SD10W153	3.8	0.61	3.5
SETTLER CL	3.4	0.49	3.5
SMOKY HILL	3.2	0.57	3.5
SY WOLF	2.7	0.67	3
TAM 107	3.7	0.43	3.5
TOMAHAWK	2.8	0.43	2.5
VISTA	2.4	0.65	3

Table 1. Continued			
Line	Mean	Standard deviation (sd)	Mode
WB-MATLOCK	2.9	0.73	3.5
WESLEY	3.1	0.55	2.5

Figure 1. Alice winter wheat during the early spring already displays the lighter green and beginning mosaic yellowing in the two inoculated rows to the right of the plot stake. The two rows on the left of the stake are the control rows in the plot.

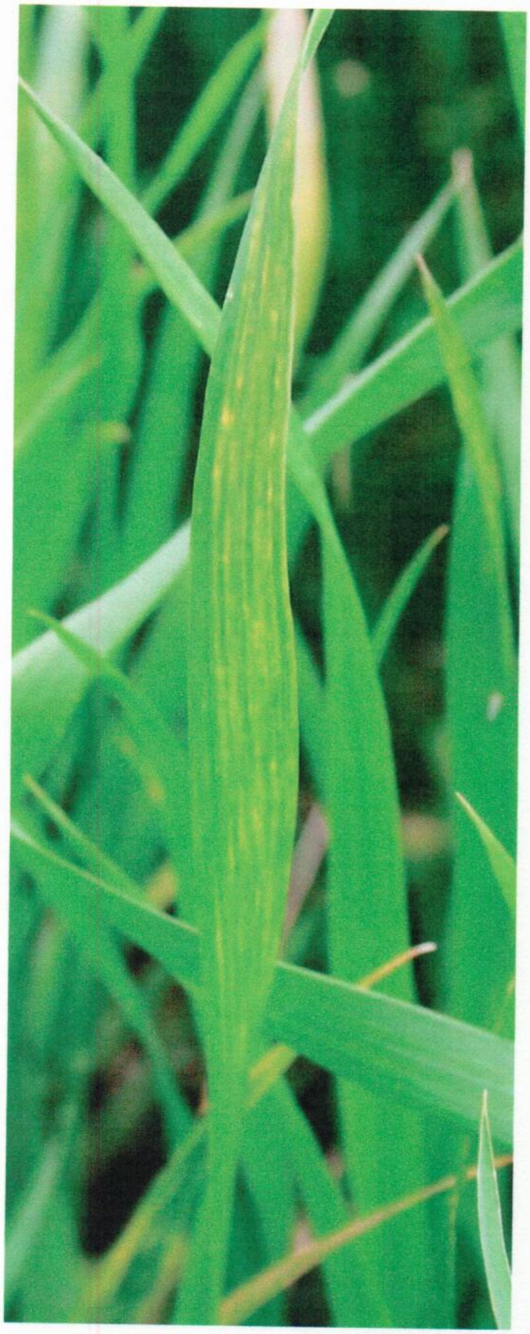

Figure 2. Early signs of mosaic streaking caused by WSMV in the winter wheat line Art.

Table 2. Yield loss (%) caused by WSMV calculated by comparing the yields of the inoculated half from the split plots in the 2012 WSMV Nursery to the control half for each plot.

Wheat Lines	Mean Loss (%)	Standard deviation
VISTA	14.17	19.85
HAWKEN	16.38	9.61
EVEREST	17.24	21.70
SD10123	17.29	23.78
JERRY	17.49	15.69
SD07W083-7	18.03	9.47
MACE	25.54	12.49
SD09140	26.68	17.57
WB-MATLOCK	27.29	11.40
FULLER	27.38	31.04
SD09034	28.47	8.14
TOMAHAWK	29.33	6.87
ART	30.36	14.39
SD10048	30.37	31.78
CAMELOT	30.55	15.77
SD10135	30.61	15.82
ROBIDOUX	31.71	17.39
SD10020-2	33.61	14.58
SD07W083-4	36.45	14.58
SD09138	37.33	17.67
ARAPAHOE	39.36	41.45
OVERLAND	39.46	23.35
SD10W006-1	39.69	8.78
SY WOLF	41.37	11.88
HV9W06-722	42.76	18.55
SD10066	42.89	25.81
SD10215-1	42.90	14.74
SD09118	43.16	17.09
MILLENNIUM	43.18	22.24
MCGILL	43.91	20.53
SD08080	44.76	9.48

Table 2. Continued		
Wheat Lines	Mean Loss (%)	Standard deviation
SD10257-2	44.88	21.49
HV9W05-1125R	45.50	15.47
SD10026-2	47.06	36.95
SD09161	48.05	10.69
SD10027-2	48.08	5.36
SD07184	49.53	14.33
SD09113	50.36	25.89
LYMAN	51.56	19.07
DAWN	52.80	15.44
SD10026-4	52.94	8.59
SD10015-2	52.99	35.34
SMOKY HILL	53.93	24.02
SD08196	54.98	29.10
SD05085-1	57.31	3.73
SD09227	57.99	21.73
SD06158	59.25	13.74
SD08200	59.28	13.99
SD10109-2	59.31	26.60
SD10216	59.44	6.08
ALICE	59.72	0.72
TAM 107	62.76	16.37
SD09192	62.93	11.94
SD08141	64.31	6.16
SD09117	65.09	16.15
SETTLER CL	66.02	14.12
SD10020-1	66.04	2.02
SD10W153	66.51	7.61
WESLEY	68.75	11.27
EXPEDITION	69.11	21.32
SD09211	69.30	10.53
IDEAL	75.88	11.88
SD10097-1	75.98	11.11
JAGALENE CK	76.51	2.29

Note: Values given in red denote lines that had one plot whose values were not utilized due significant stand problems or other damage.