South Dakota Wheat Commission
FY15
Report on Research Findings and Status

EVALUATION OF WHEAT FOR RESISTANCE AND RESPONSE TO VIRAL DISEASES IN SOUTH DAKOTA

Principle Investigator--Dr. Marie A. C. Langham; Plant Virology, SDSU
Collaborator—Dr. Sunish Sehgal; Winter Wheat Breeding, SDSU

Introduction to Research--*Wheat streak mosaic virus* (WSMV) (Family: *Potyviridae*; Genus: *Tritimovirus*) causes the viral disease with the greatest impact on South Dakota wheat production. Winter wheat losses due WSMV (averaged across South Dakota) are at a minimum 2.5-5 million bushels, annually. Greater losses occur during epidemic years, and WSMV can be devastating particularly in Western South Dakota. South Dakota's cropping system with winter wheat, spring wheat, and corn as well as abundant native and introduced grasses provides the perfect environment for WSMV and its vector, the wheat curl mite (*Aceria tosichella* Kiefer). Wheat curl mites move WSMV to winter wheat in the fall where both WSMV and the mite remain through the fall and winter. WSMV stunts the early growth stages of winter wheat roots and shoots by up to 40% during fall infection, and it is also one of the factors contributing to winter kill. WSMV management differs from management of bacterial and fungal pathogens, because there are no effective strategies to treat plant viruses once they have infected a plant. WSMV control depends on development of preventative disease management strategies. The most effective of these strategies is the development and deployment of host plant resistance or tolerance. Efforts to develop winter wheat cultivars with higher levels of WSMV resistance/tolerance require annual evaluation of plant materials to determine their susceptibility or resistance. Without this process, susceptible materials will not be eliminated from breeding programs, and previous advances in resistance and tolerance will be lost. Evaluation of winter wheat breeding materials is the focus of this research project.

Research Summary and Challenges—The 2015 WSMV Winter Wheat Evaluation Nursery was planted in September 2014. Thirty-five entries were selected from the SDSU Winter Wheat Breeding Program Advanced Yield Trials and appropriate control lines. The nursery was planted into spring wheat stubble using no-till. When the entries in the nursery began to emerge, spring wheat volunteers abundantly covered the field also. Unfortunately, they were so thick that in many areas of the field, the rows of winter wheat could not be distinguished from the spring wheat volunteers. Thus, the only viable option was to postpone inoculation of the winter wheat until spring and allow the spring wheat to be winter killed. The WSMV Winter Wheat Nursery is usually inoculated in the fall to best simulate the most prevalent infection period in winter wheat when wheat curl mites move WSMV into newly emerging winter wheat. Inoculation in the spring more closely parallels the secondary movement of the wheat curl mite in the spring when it multiplies and disseminates WSMV. Additionally, this meant that all of the infected wheat prepared for the fall inoculation would not be viable by spring as it only has a 3-4 month viability frozen, and new infected wheat for WSMV inoculum had to be grown, harvested, chopped, and frozen.

When spring arrived, weather issues and personnel changes forced the WSMV inoculation of the wheat nursery to be done at a much later time than typically utilized for spring inoculations. Wheat lines had begun to boot before the inoculation could be done. Typically, conventional models for WSMV development in field situations indicate that wheat infected at this stage will not be seriously affected and yield losses will be minimal. Preliminary data from the 2015 WSMV Winter Wheat Nursery both supports and conflicts with this conventional wisdom. Support for greatly decreased damage from WSMV infection in the late spring is provided by the following points:

- *Stunting*—Fall infection typically results in wheat lines that are stunted in almost every line evaluated. Some fall-inoculated lines grow less than half as tall as the uninoculated half of the plot. The 2015 spring-inoculated entries had only nine entries that demonstrated any stunting. Of these, the most severely stunted were Dawn (2.6 cm shorter), SD13137-1 (2.7 cm shorter), SD11023-8 (2.7 cm shorter), and SD13221-5 (2.7 cm shorter). The remaining five of these stunted entries were stunted less than 2 cm (1 in).
- *Heading Delay*—Delays in heading date in WSMV Winter Wheat Evaluation Nurseries inoculated in the fall are typically found to be several days when compared to the uninoculated half plot. Delays as long as two weeks have been found in some entries. The 2015 spring-inoculated winter wheat entries had only three entries (SD13099-8, SD13238-3, and SD11002-2) in the preliminary data whose heading was delayed by a mean of 1 day and twelve entries with a mean heading delay of only a fraction of a day. Thus, these entries did not demonstrate the extended delay typical of fall inoculation.
- *Disease Severity Rating (DSR)*—Symptom severity in the late spring-inoculated 2015 WSMV Winter Wheat Evaluation Nursery was not as severe as typically found in fall-inoculated lines. The range in DSR for a fall-inoculated nursery typically ranges from 1-5 with 5 representing the most severe symptoms. The spring-inoculated lines ranged in severity from 1-3. Preliminary data from the 2015 nursery found Lyman, SD10215-1-1, SD10W089-3-5, SD110041-4, SD12007-6, and SD13133-1 demonstrated the most severe symptoms during this year.

These three characters indicate that the late spring inoculation did not impact the winter wheat lines as severely as fall infection does. It is important to note that these are characters that are easily visually noted when examining typical fields and assessing how severe a disease problem is. However, preliminary data from the 2015 WSMV Winter Wheat Evaluation Nursery indicates that this may not be the complete picture as can be seen in the following:

- *Yield Loss (%)*—The late-spring inoculated winter wheat entries demonstrated mean yield losses ranging from none to 45.4%. The entries with the greatest yield losses include SD13099-8 (20.3%), SD13W064-7 (21.0%), SD11002-2

(22.5%), SD10W153 (23.5%), Tomahawk (27.3%), Overland (27.4%), SD13131-5 (28.6%), SD13066-5 (28.7%), SD12007-6 (29.1%), SD13238-3 (32.2%), Lyman (35.3%), Dawn (35.9%), SD110041-4 (36.5%), and SD13133-1 (45.4%). In fall-inoculated entries, it is not uncommon for the most severely affected lines to have losses in the 50-80% range. So, the spring-inoculated lines were not as severely affected overall; however, these losses represent an impact on the winter wheat entries greater than conventional models and paradigms would indicate. Also, it indicates that that cultivars may vary in their ability to withstand late spring inoculation.

- *Test Weight Loss (%)*—All winter wheat entries except SD13W064-7 demonstrated loss in test weight when inoculated with WSMV in the late spring. These losses in test weight range from 1.5% to 18.4% in the preliminary data. The six entries with the greatest loss in test weight include: SD110041-4 (9.0%), SD13066-5 (9.1%), SD13131-5 (9.9%), SD13238-3 (10.1%), SD11023-8 (11.0%), and SD13133-1 (18.4%). Clearly, the winter wheat entries varied in the impact that WSMV had on test weight; however, this impact is another character that is greater than would be indicated by conventional models and paradigms of WSMV disease mechanisms.

In conclusion, work continues on the ELISA analysis of the samples taken from the winter wheat entries. However, preliminary data indicates that three of the traits measured (stunting, delay in heading date, and disease severity rating) were not impacted as severely by late-spring inoculation as is typically found in early-fall inoculations. Yield loss and test weight loss were more severely impacted by the late-spring inoculation; although, it was not as severe as fall inoculation. Conventional models and paradigms for WSMV disease development indicate that late-spring inoculations with WSMV would cause little damage. Three characters (stunting, delay in heading date, and disease severity rating) agree with this model. Yield losses and test weight losses contradict this and demonstrate that at least some entries are severely impacted by even late-spring infection by WSMV. It is also worth noting that stunting, delay in heading, and disease severity are highly visible during the growing season and that a lack of these visual symptoms may have led to the premise that WSMV impact was greatly reduced in late-spring infection. These findings indicate caution should be used when reassuring producers that late-spring WSMV infection will not have an impact on their yield.

Note on FY16 WSMV Winter Wheat Evaluation Nursery—The nursery was planted in September and was inoculated in October. This nursery contain forty entries.