Progress Report for
South Dakota Wheat Commission FY16 Grant
Marie A. C. Langham

Project Data:

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

Reporting Period: July 1, 2015-September 30, 2016

Total Project Period: July 1, 2015-March 30, 2016 (includes a 9 month no cost extension)

Report Type: Progress Report

Personnel: Marie A. C. Langham; Professor, Plant Virology Project;
South Dakota State University; Department of Agronomy, Horticulture, and Plant Science; Plant Science Building; PO 2108; Brookings, SD 57007
Phone: 605-688-5539
E-mail: marie.langham@sdstate.edu

Collaborator: Sunish Sehgal; Assistant Professor, Winter Wheat Breeding Project:
South Dakota State University; Department of Agronomy, Horticulture, and Plant Science; Seed Technology Laboratory; PO2108; Brookings, SD 57007
Phone:605-688-5709
E-mail: sunish.sehgal@sdstate.edu

Research Summary: The 2016 WSMV Winter Wheat Nursery was successfully grown, inoculated, and the agronomic traits were measured. Comparisons of each line entered in the nursery can be found in the Publications/Data section. Yield losses are compared in Figure 1. Yield losses ranged from 10.6% to 74.5% of the grain yield in the uninoculated split plot. Losses in test weight are compared in Figure 2. They ranged from -0.26% to 15.4% of the test weight from the grain produced by the uninoculated split plots. These two traits clearly impact directly on the producer's production and profitability.

The remaining three traits have impacts that are not as directly perceived. Stunting is the reduction in plant height found in the inoculated split plots when compared to the uninoculated plots. The correlation between stunting and straw mass is easily perceived, but on the surface, stunting might not seem to be a trait that would impact yield and overall performance. However, stunted infected plants are often shaded by other uninfected plants that have grown taller. This shading effect decreases the amount of sunlight for photosynthesis that is available to stunted plants and lessens their carbohydrate potential. Additionally, the shorter and shaded plants tend to have more moisture on their leaves and retain this moisture for longer periods. Extended moisture periods increase the risk for these plants to develop bacterial leaf streak and rust. Stunting is compared in Figure 3. Height reductions in the WSMV inoculated plots ranged from 0.1-18.8 cm.

Delays in heading date represent the slower development and maturity of WSMV inoculated plants. During years with adequate moisture, the impact of this delayed maturity may be lessened by the plant's ability to continue to produce and store carbohydrates and proteins longer. However, during years when moisture levels drop early in the season, delayed plants may not be able to reach maturity before drying. Thus, this trait has a

greater impact in some years than others. Figure 4 compares the delays in maturity measured during the 2016 WSMV Winter Wheat Nursery. Delays in heading ranged from 0 to 10.7 Julian days. Lines with significantly delayed heading would be at great risk during drought years.

Disease severity rating (DSR) is a scale used to compare the severity of the symptom development in WSMV inoculated cultivars. It ranges from 0 (no visible symptoms) to 5 (very severe mosaic and stunting with necrosis and death). Severity of symptoms can parallel the destruction of chloroplasts and their decreased capacity for photosynthesis. DSR values averaged from 1.3 to 3.8 in the WSMV inoculated split plots.

Table 1 combines the outcomes of these five traits by ranking the performance of each line for each trait by using 1 for the line demonstrating the least loss or damage and 40 for the line demonstrating the greatest loss or damage. Utilizing the rankings aids in selecting lines that performed well in multiple traits. For example, SD11060-7 was highest ranked line in yield loss, stunting, and DSR. It was second in test weight losses and fourth in heading delay. Thus, SD11060-7 is the line with the best overall performance. Lines with high rankings (indicating the most loss or damage) included lines such as SD12010-5, SD14168, and SD10109-2-4. These three lines ranked from 34 to 40 for all traits indicating that they have a high susceptibility to WSMV.

Yield loss, test weight loss, stunting, delay in heading, and DSR demonstrate a clear differentiation in the winter wheat lines evaluated. This information will be important in evaluation of lines for advancement by the Winter Wheat Breeding Program.

Introduction: The *Evaluation of Winter Wheat for Resistance and Response to Viral Diseases in South Dakota* assesses winter wheat lines for susceptibility, tolerance, or resistance to *wheat streak mosaic virus* (WSMV) (Family: *Potyviridae*; Genus: *Tritimovirus*). This evaluation is based on the agronomic responses and virus levels in winter wheat lines when inoculated with WSMV. This is a collaborative research project with the Winter Wheat Breeding project. The nursery is focused on lines being developed by Winter Wheat Breeding and on lines needed for future breeding crosses. Winter wheat cultivar development in South Dakota requires annual evaluation for WSMV effects. Without this process, susceptible materials cannot be eliminated from the breeding program, and previous gains in resistance/tolerance will be lost.

Methods: In the WSMV Winter Wheat Nursery, winter wheat lines from the Advanced Yield Trials (AYT) and Crop Performance Trials (CPT) was planted in four-row plots (three completely randomized blocks). A split plot design was created by inoculating two rows of each plot with WSMV-infected sap extract [pressed from a macerated mixture (1:10 w:v WSMV-infected Arapaho winter wheat:0.02 M potassium phosphate buffer, pH 7.0) with 1% silica carbide added] using high-pressure spray (80 PSI) to penetrate the wheat's epidermis. The remaining two rows in each plot were not inoculated. Disease severity, WSMV infection levels (as determined by ELISA), yield, test weight and other agronomic measures were collected from both inoculated and non-inoculated rows of each plot. Utilizing split plots for this research greatly reduces the impact of environmental differences of the field on differential comparisons between the WSMV-inoculated and non-inoculated values.

Description of Accomplishments: The following outlines the objectives which have been accomplished and those which remain to be finished in the remaining grant period.

- **Objectives that have been accomplished:**

- 2015 WSMV Winter Wheat Evaluation Nursery (Data was reported in a previous report.)
  - Collection of disease severity ratings
  - Collection of plant heading dates (delay in maturity)
  - Collection of plant heights (stunting)
  - Collection of plant samples for analysis
  - Harvest of grain
  - Yield and yield loss determination
  - Test weight and test weight loss determination

- 2016 WSMV Winter Wheat Evaluation Nursery
  - Planning and establishing 2016 WSMV Winter Wheat Evaluation Nursery
  - Production of 100 kg of WSMV-infected wheat
  - Production of 225 liters of WSMV inoculum
  - Inoculation of 2016 WSMV Winter Wheat Evaluation Nursery
  - Collection of disease severity ratings
  - Collection of plant heading dates (delay in maturity)
  - Collection of plant heights (stunting)
  - Collection of plant samples for analysis
  - Harvest of grain
  - Yield and yield loss determination
  - Test weight and test weight loss determination

- **Objectives that remain to be accomplished:**

  - 2015 WSMV Winter Wheat Evaluation Nursery
    - ELISA analysis of nursery samples

  - 2016 WSMV Winter Wheat Evaluation Nursery
    - Analysis of field data
    - ELISA analysis of nursery samples

Projections: In the request for the extension, the goals for this project were revised to include much of the field work and analysis for the 2016 WSMV Winter Wheat Nursery which was standing in the field at that time that were part of the unfunded grant proposal. This has caused shifts to be made in some of the time lines, primarily with how fast that the ELISA analysis can be finished. However, good progress is being made and is expected to continue in a timely manner.

Publications/Data:

The field results from the 2016 are in the following figures:

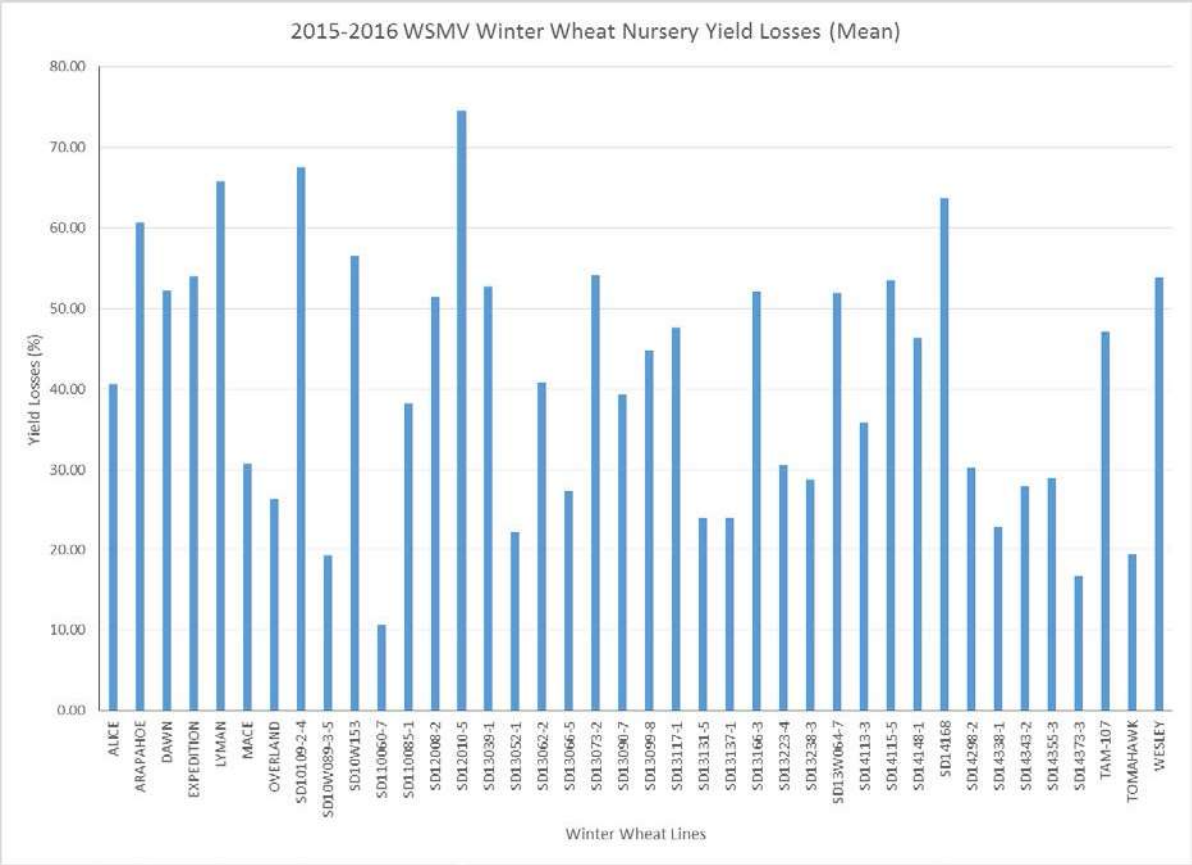

Figure 1. Losses in total yield caused by WSMV infection in winter wheat lines. The losses are represented by the percentage of loss when compared to the yields from uninoculated winter wheat lines.

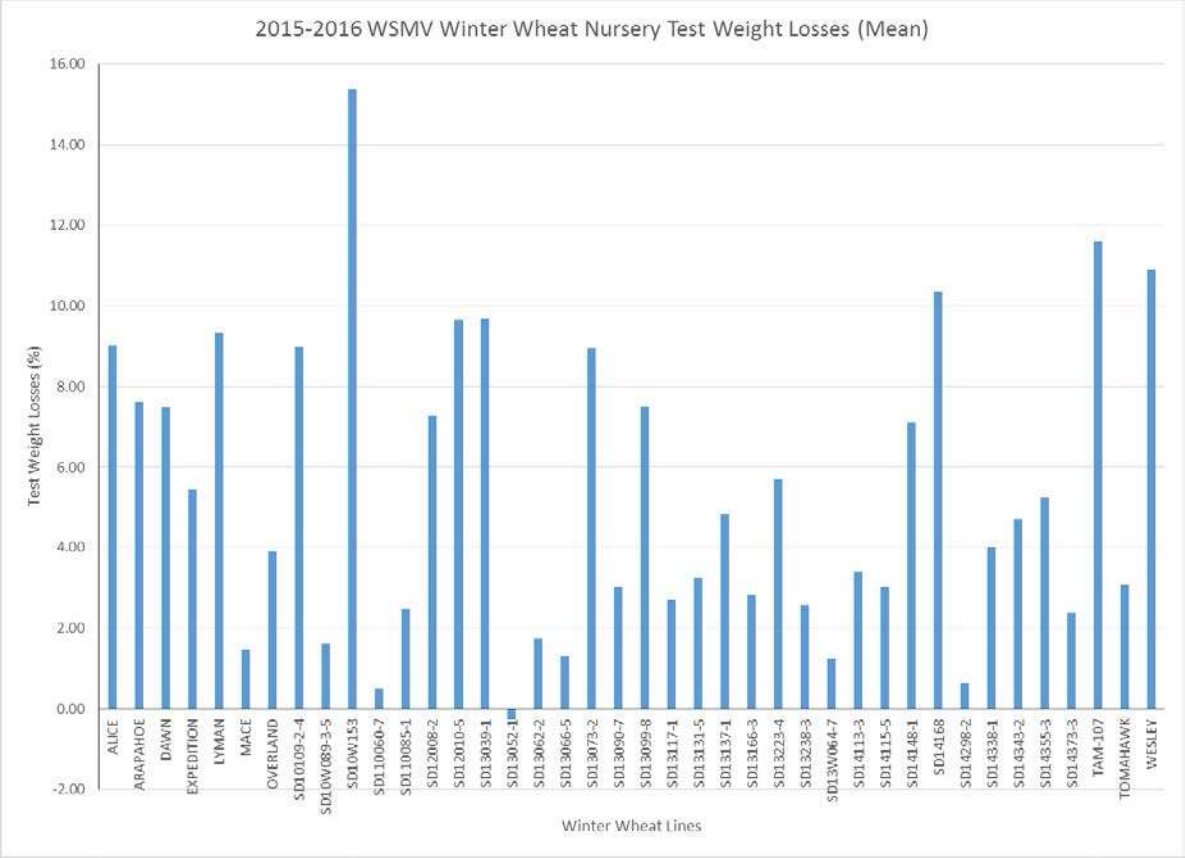

Figure 2. Losses in test weight caused by WSMV infection in winter wheat lines. The losses are represented by the percentage of loss when compared to the test weights from uninoculated winter wheat lines.

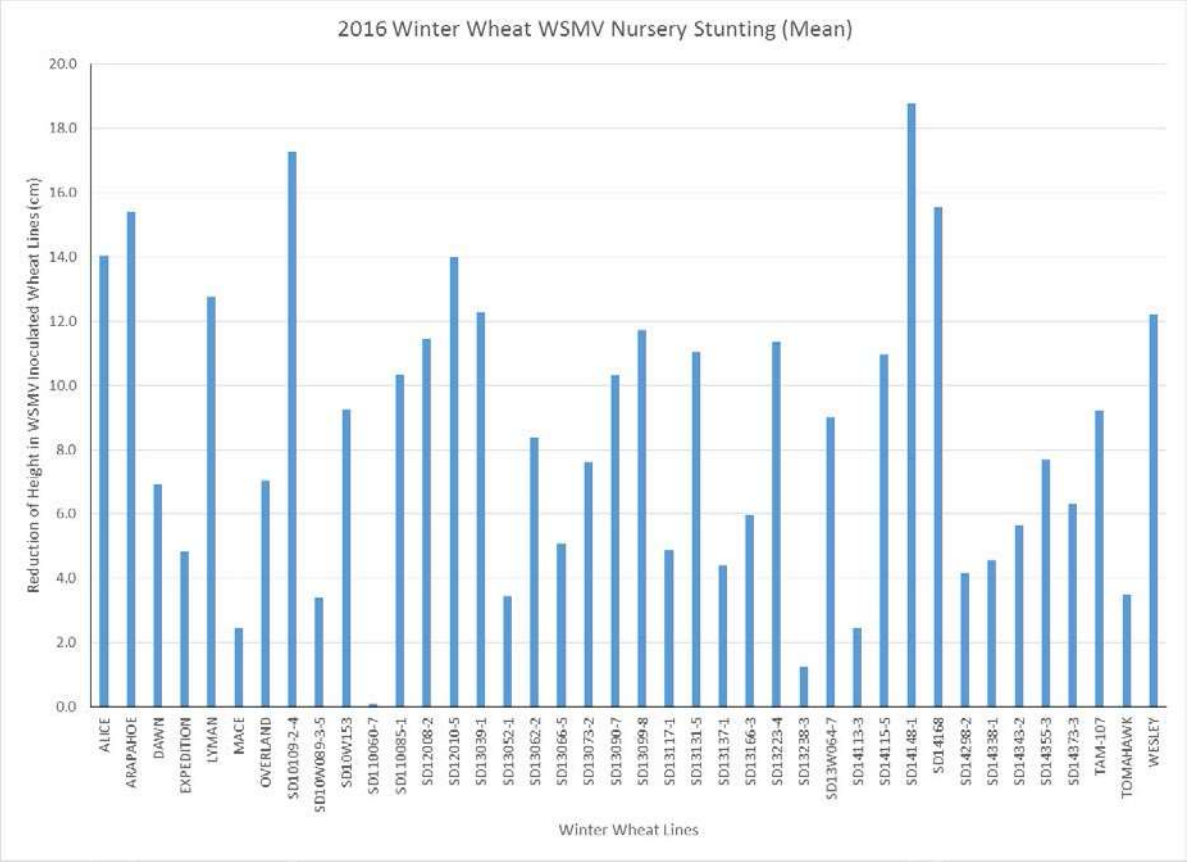

Figure 3. Reductions in height (cm) caused by WSMV infection in winter wheat lines. The reductions are represented by the differences in height when compared to the heights from uninoculated winter wheat lines.

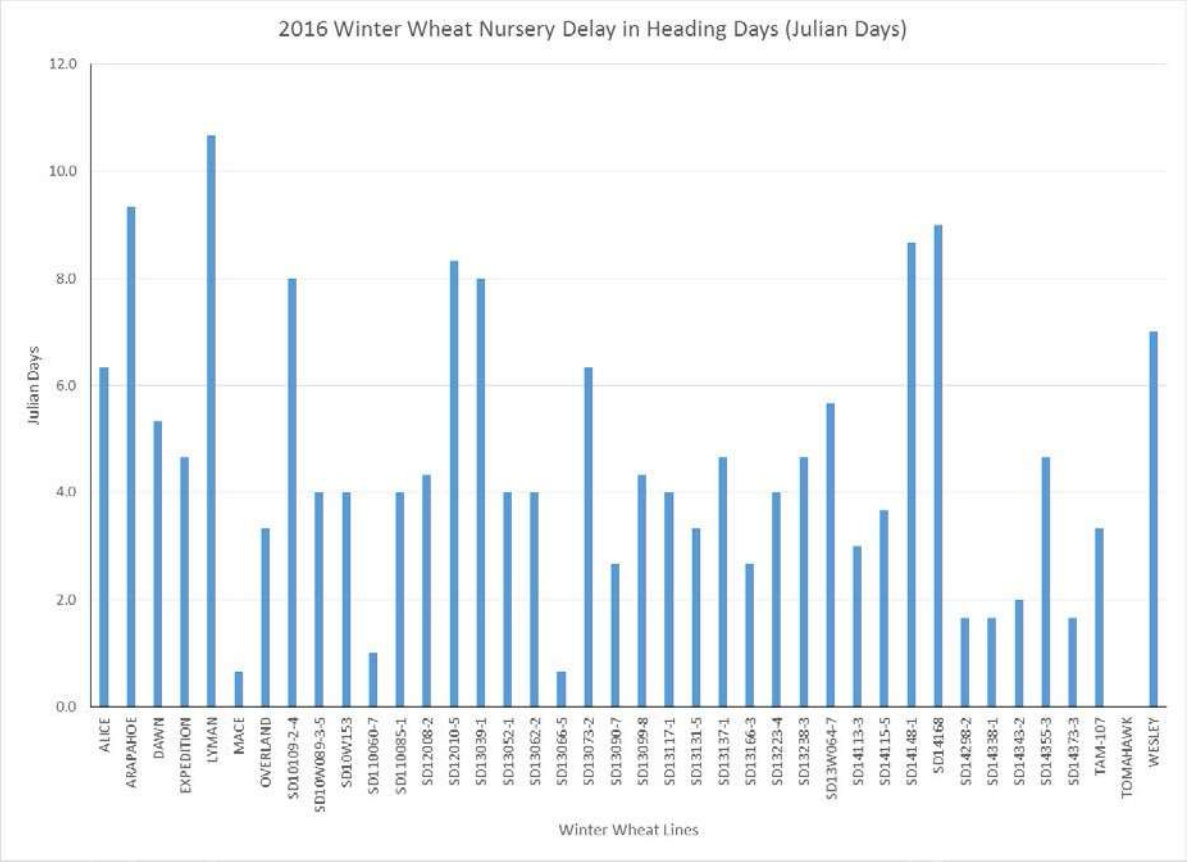

Figure 4. Delays in heading dates (Julian days) caused by WSMV infection in winter wheat lines. The maturity delays are represented by the differences in heading dates when compared to the heading dates from uninoculated winter wheat lines.

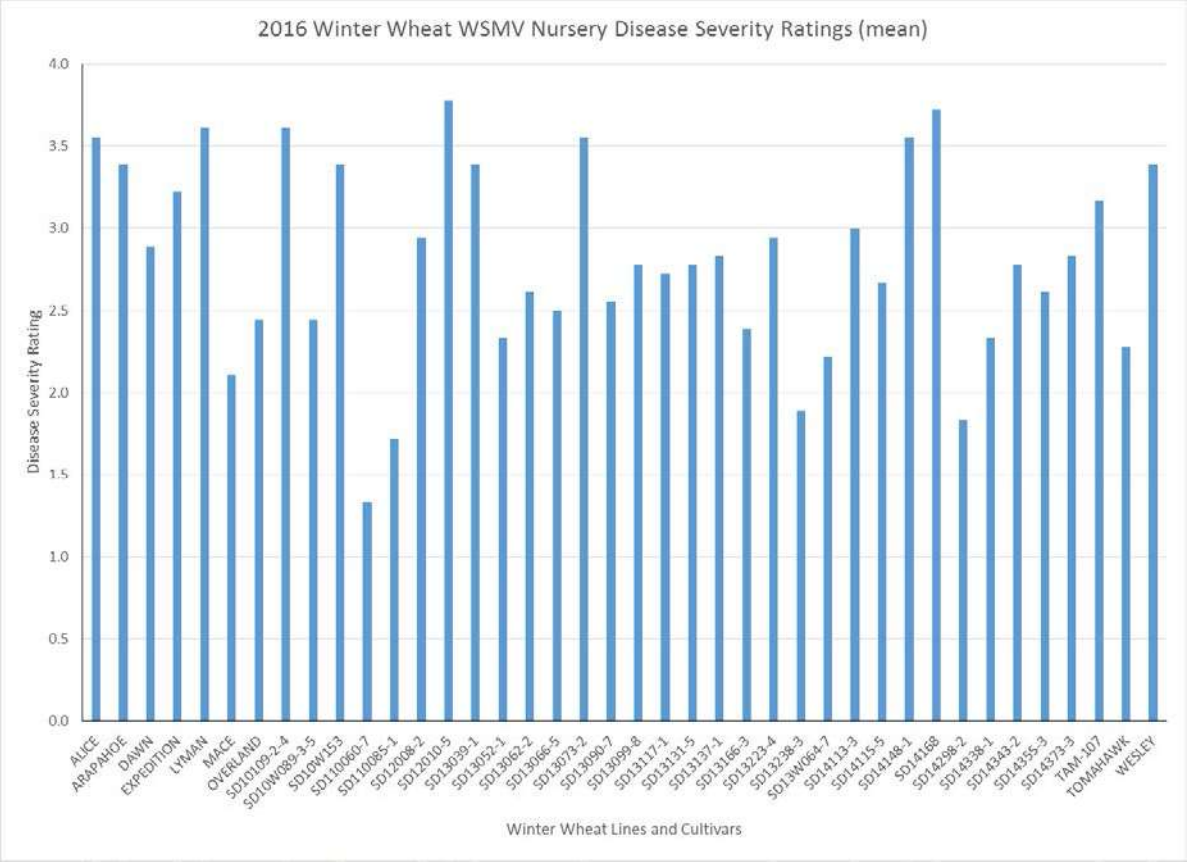

Figure 5. Disease severity reactions caused by WSMV infection in winter wheat lines. Disease severity ratings are rated on a basis of 0 (no symptoms; no differences from plants) to 5 (extremely yellowing, stunting, and necrosis) when compared to uninoculated winter wheat lines.

Table 1. Entries in the 2016 WSMV Winter Wheat Nursery and their ranking in each trait measured is shown in the table. Each entry is ranked from the one showing the least loss or damage (1) to the one showing the greatest loss or damage (40) for each trait that was measured.

Entries in the 2016 WSMV Winter Wheat Nursery Ranked by Performance					
Line	Yield Loss	TW Loss	Stunting	Heading Delay	DSR
ALICE	20	33	36	31	34
ARAPAHOE	36	30	37	39	30
DAWN	29	28	17	29	24
EXPEDITION	33	24	11	25	29
LYMAN	38	34	34	40	37
MACE	16	6	4	2	5
OVERLAND	9	19	18	12	11
SD10109-2-4	39	32	39	34	38
SD10W089-3-5	3	7	5	16	12
SD10W153	35	40	24	17	31
SD110060-7	1	2	1	4	1
SD110085-1	18	10	26	18	2
SD12008-2	26	27	30	23	25
SD12010-5	40	35	35	36	40
SD13039-1	30	36	33	35	32
SD13052-1	5	1	6	19	8
SD13062-2	21	8	21	20	15
SD13066-5	10	5	13	3	13
SD13073-2	34	31	19	32	35
SD13090-7	19	15	25	9	14
SD13099-8	22	29	31	24	19
SD13117-1	25	12	12	21	18
SD13131-5	8	17	28	13	20
SD13137-1	7	22	9	28	22
SD13166-3	28	13	15	10	10
SD13223-4	15	25	29	22	26
SD13238-3	12	11	2	26	4
SD13W064-7	27	4	22	30	6
SD14113-3	17	18	3	11	27
SD14115-5	31	14	27	15	17
SD14148-1	23	26	40	37	36
SD14168	37	37	38	38	39
SD14298-2	14	3	8	5	3
SD14338-1	6	20	10	6	9
SD14343-2	11	21	14	8	21
SD14355-3	13	23	20	27	16
SD14373-3	2	9	16	7	23
TAM-107	24	39	23	14	28
TOMAHAWK	4	16	7	1	7
WESLEY	32	38	32	33	33

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