A comparison of recommended and high seeding rates and zero-fungicide and recommended fungicide treatments for South Dakota wheat growers

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Research Summary:
An appropriate spring wheat seeding rate to eliminate plants per acre as a yield limiting factor is questioned on a regular basis because genetics, environment, management and their interactions do change over time. Variety selection (3 varieties), seeding rate (1.2, 1.8, & 2.4 million seeds/ac), and foliar fungicide (Triazole-class at flowering) application were evaluated within one experimental design to assess these management decisions and their interactions in eastern South Dakota from 2010-2013 (two locations per year). Results of the study suggest that in most years, a 1.2 million pure-live-seeds (PLS)/ac rate will maximize yield. A decrease in the number of heads per plant was main reason yields were not increased with higher seeding rates. In certain environments with some varieties, growers may benefit from increasing seeding rates from 1.2 to 1.8 million PLS/ac. However, higher seeding rates (>1.8 million PLS/ac) were never warranted. Increases in yield from foliar fungicide application resulted from an increase in seed size. Apply a foliar fungicide on susceptible varieties when the disease pressure and environment are conducive to receive a return on investment (fungicide + application cost > yield x price). Lodging risk can be reduced through variety selection, lower seeding rates, and foliar fungicide. Improved variety selection tools for producers will help increase yields and profitability of spring wheat production in South Dakota. Future research may consider quantifying tillering potential of spring wheat varieties grown in South Dakota as means of suggesting the 1.2 versus the 1.8 million PLS/acre seeding rate recommendation.

Introduction:
Currently, the SDSU Extension has two seeding rate recommendations for spring wheat in South Dakota. Planting 1.2 million PLS/ac or about 28 PLS/ft^2 was the standard recommended planting rate for many years. Many agri-business agronomists have suggested that a seeding rate of 2.4 million PLS/ac or 56 PLS/ft^2 is more realistic for producers using intensive management practices. Past research at SDSU by Robert Hall had indicated that there were no significant yield advantages to raising the recommend

seeding rate of 28 PLS (1X), to rates of 42 PLS (1.5X), and to 56 (2X)/ft^2. These seeding rates are equal to 1.22, 1.83, and 2.44 million PLS/ac, respectively. Previous research by Robert Hall also determined the 1X, 1.5X, and 2X seeding rates resulted in 1.8, 1.4, and 1.1 harvested heads for each seed planted. The 1X rate produced one main and 0.8 secondary heads/plant, while the 2X rate resulted in one main and only 0.1 secondary heads/plant, or essentially on main head per plant.

In 2007, SDSU Extension, as the result of testimonials from individual growers and agribusiness, comprised and recommended that growers using intensive management practices, have poor seed bed conditions, or late plantings increase the seeding rate to 1.8 million PLS/ac or 42 PLS/ft^2. Many field agronomists felt, that although higher seeding rates did not increase yields, it did produce more main but fewer secondary heads. This was important to them because, main heads flower first, followed by any secondary and tertiary heads. Thus, the flowering period would be more uniform and shorter allowing more targeted applications of fungicide at flowering to protect heads from Fusarium head blight and the plant from other diseases. Although, SDSU currently has two spring wheat seeding rates of 1.2 (standard) and 1.8 (intensive or late-seeding) million PLS/ac, there are still many questions regarding the seeding rate issue for South Dakota. Questions include (1) is the intensive management seeding rate sufficient or should it be raised to 2.44 million PLS? and (2) does either the 1.83 or 2.44 million PLS/ac really result in improved fungicide coverage and higher yield compared to the standard seeding rate? If seed costs increase, seeding rate recommendations can become a significant factor in production input costs.

The objectives of the study were to determine if (1) seeding rate, (2) fungicide applications, and/or their interactions affect spring wheat yields.

Description of Accomplishments:

Methods – The study was conducted at two locations each year (Table 1). The South Shore, Brookings, and Volga locations were located on the SDSU Research Farms and Warner, SD (Brown County) with a farmer cooperator. The experimental design at all location was a stratified split-plot design. There were 72 plots per location (3 varieties x 3 seeding rates x 2 fungicide treatments x 4 blocks). A small plot cone drill with 8 inch row spacing was used and plots were 5 feet by 12 or 13 ft long at harvest. Plots were fertilizer for a 100 bu/ac yield goal. Foliar fungicide (2 oz of Folicur – Triazole class) was sprayed at early flowering. Seeding rates were adjusted based on a germination percentage to achieve the same pure-live-seed (PLS) seeding rate for each variety and year : 28 PLS/ft^2 (1X rate or 1.2 million PLS/ac, 42 PLS/ft^2 (1.5X rate of 1.8 million PLS/ac, and 56 PLS/ft^2 (2X rate or 2.4 million PLS/ac). Yield, yield components (seeds/head etc.), test weight, protein, lodging, and plant height were measured. The variety 'Select' replaced 'Briggs' in 2011 (Table 1).

Table 1. Year, locations, varieties, and seeding rates.

Year	Location 1	Location 2	Variety	Seeding rate†
2010	Warner	Brookings	Brick/Briggs/Howard	1.2, 1.8, 2.4
2011	Warner (Lost)	South Shore	Brick/Select/Howard	1.2, 1.8, 2.4
2012	Volga	South Shore	Brick/Select/Howard	1.2, 1.8, 2.4
2013	Volga	South Shore	Brick/Select/Howard	1.2, 1.8, 2.4

† Million seeds per acre

Table 2. Yield responses by year averaged across locations and across all locations (7) and years (2010-2013).

Year	Yield			Variety			Fungicide	
	1.2 PLS/ac†	1.8 PLS/ac	2.4 PLS/ac	Brick	Briggs/Select	Howard	No	Yes
2010	55.1	55.3	55.0	54.2b	52.5c	**58.7a#**	52.7b	**57.6a**
2011§	33.7	33.4	33.7	32.3	**37.1a**	31.4	31.2b	**36.0a**
2012‡	45.2	47.5	48.1	45.7b	**49.2a**	45.9b	46.1b	**47.8a**
2013	**53.9a**	**54.0a**	50.2b	51.4b	51.5b	**55.2a**	50.8b	**54.6a**
2010-2013	46.1	46.6	45.6	45.5b	-¶	48.0a	44.0b	**48.2a**

† Million seeds per acre
§ Fungicide x Variety x Seeding rate interaction,
‡ Variety by seeding rate interaction, increase in yield with from 1.2 to 1.8 million PLS/A in variety Brick and Howard, but not with Select.
# Numbers within each treatment (seeding rate or variety or fungicide) followed by different letters are statistically different at the 0.05 probability level.
¶ Briggs and Select not reported since not tested all 4-years.

Table 3. Protein%, Test Weight, and Lodging across all locations (7) and years (2010-2013).

Year	Yield			Variety			Fungicide	
	1.2 PLS/ac†	1.8 PLS/ac	2.4 PLS/ac	Brick	Briggs/Select‡	Howard	No	Yes
Protein (%)	15.4	15.4	15.4	15.3b	-	**15.5a#**	15.3b	**15.5a**
Test Weight (lbs/bu)	56.0	56.0	56.1	56.3	-	56.1	56.0	56.1
Lodging (1 to 5)§	**2.6a**	2.9b	3.1c	2.7	-	2.7	3.0b	**2.7a**

† Million seeds per acre
‡ Briggs and Select not reported since not tested all 4-years.
§ Lodging scale 0 = all plants erect, 3 = 50% of plants lodged at 45°, 5= all plant flat.
# Numbers within each treatment (seeding rate or variety or fungicide) followed by different letters are statistically different at the 0.05 probability level.

Table 4. Yield components across all locations (5) and years (2010-2012¶).

Year	Yield				Variety		Fungicide	
	1.2 PLS/ac†	1.8 PLS/ac	2.4 PLS/ac	Briggs	Briggs-Select††	Howard	No	Yes
Heads/planted seed‡	2.2	1.5	1.1	1.5	-	1.6	1.6	1.6
Head/ft^2‡	61	62	62	58	-	62	61	62
Seeds/Head	**16a#**	15b	14c	**17a**	-	15b	15	15
Seeds/ft^2§	929	965	882	985	-	923	913	938
Seeds/lb	16,408	16,622	16,811	17,004b	-	**16,618a**	16,910b	**16,318a**

† Million seeds per acre
‡ Variety by seeding rate interaction,
§ Variety x Seeding rate interaction was from the a decrease in seed/ft^2 with Briggs, but no change in with other varieties with seeding rate. Variety x Fungicide interaction in the variety Howard, which had higher number of seeds with a fungicide whereas the other varieties did not.
# Numbers within each treatment (seeding rate or variety or fungicide) followed by different letters are statistically different at the 0.05 probability level.
¶ Yield components (heads/seed planted, heads/ft2, seeds/head, seeds/ft2, seed size) for the 2013 growing season are still being measured the data in be incorporated into later publications to stakeholders.
†† Briggs and Select not reported since not tested all 4-years.

Results based on the 4-yr study:

1. Variety selection affected yield (3.3 to 6.2 bu/ac) during each year of the study
2. There were no yield differences, less than 1 bu/acre, between the three seeding rates of 1.2, 1.8 and 2.4 million PLS/ac. However, in 2012, increasing seeding rates from 1.2 to 1.8 million seeds/ac in two of the three varieties did increase yield, but no additional increase was measured with a seeding rate of 2.4 million PLS/ac. In 2013, the 2.4 million PLS/ac rate decreased yield by 3.8 bu/ac versus the lower two seeding rates.
3. Increasing seeding rates from 1.2, 1.8, and 2.4 million PLS/ac resulted in roughly 2.2, 1.5 and 1.1 heads per plant, respectively.
4. Protein% was not affected by seeding rate, but variety selection and foliar fungicide did increase protein.
5. Test weight was not affect by seeding rate of foliar fungicide application.
6. Lodging was significantly increased with increasing seeding rates, affected by variety selection, and reduced with a fungicide application.
7. Fungicide application significantly increased yield each year of the study, with an average response of 4.2 bu/ac, regardless of the seeding rate and variety. Seed size on the only yield component increased by the foliar fungicide application.

Conclusion based on the 4-yr study:

1. Improved variety selection tools for producers will help increase yields and profitability of spring wheat production in South Dakota.
2. Lodging risk can be reduced through variety selection, lower seeding rates (1x rate), and foliar fungicide application.
3. In most years, a 1.2 million PLS/ac rate will maximize yield.
4. A decrease in the number of heads per plant was main reason yields were not increased with higher seeding rates.
5. In certain environments with some varieties, growers may benefit from increasing seeding rates from 1.2 to 1.8 million PLS/ac
6. Higher seeding rates (>1.8 million PLS/ac) were never warranted.
7. Apply a foliar fungicide on susceptible varieties when the disease pressure and environment are conducive to receive a return on investment (fungicide + application cost > yield x price).
8. Increases in yield from foliar fungicide application were the result of increased seed size.

Projections:

The objectives of the study were to determine if (1) seeding rate, (2) fungicide applications, and/or their interactions affect spring wheat yields. The 4-year study has generated the needed data to update recommended seeding rates, estimate an expected yield responses from fungicide application, highlighted the importance of variety selection, and possible interaction between these management decisions for spring wheat production in South Dakota as intended within the approved yearly budgets. Future research may consider quantifying tillering potential of spring wheat varieties grown in South Dakota as means of suggesting the 1.2 versus the 1.8 million PLS/acre seeding rate recommendation.

Publications/Data:

Data from the project will be used to write a manuscript submitted to a peer-reviewed scientific journal, an iGrow articles, and update the digital Chapter 5 "spring wheat planting guide" in the iGrow Wheat BMP book. The data will be highlighted the 2013 Ag Horizon Conference and utilized at extension events this coming year (2014).