

PROJECT NO: BJKT57

TITLE: Optimizing seeding and nitrogen fertilizer rates for winter wheat in northern Idaho

PERSONNEL: Dr. Kurtis L. Schroeder, Assistant Professor of Cropping Systems Agronomy
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JUSTIFICATION: The climate in northern Idaho and eastern Washington is highly suited for the production of soft white winter wheat due to the Mediterranean climate, having relatively mild winters and cool, wet conditions in the spring and early summer. One component of continued success of the winter wheat industry is the progressive development of new varieties that have superior performance, are well adapted to the various growing regions in northern Idaho, and have improved resistance or tolerance to pathogens and pests. As part of this effort, new genetic resources are being introduced to the region. While varieties are evaluated for yield performance and disease resistance, this is typically done using a standard fertilizer regime and seeding rate. Many agronomic factors can influence the yield and quality of a wheat crop such as seeding density, planting date, fertilizer inputs, conservation management practices, seed treatment, etc. There is interest in having variety specific agronomic data for new varieties and this project intends to address this. The intent of this project is to examine varietal response to seeding rates and nitrogen, with a focus on evaluating varieties adapted to the Pacific Northwest (PNW) and varieties of European origin that have been introduced into the PNW in recent years.

HYPOTHESIS & OBJECTIVES: The hypotheses to be evaluated are that there will be a variable varietal response to seeding and nitrogen fertilizer rates, and second that variable rate seeding will improve wheat quality and maximize yields, while reducing seed and seed treatment costs.

1. Evaluate inputs including seeding and nitrogen rate for variable response to six varieties of winter wheat at three north Idaho locations.
2. Identify the economic optimum for the various nitrogen and seeding rates for each for variety.

PROCEDURES:

1. *Variety response to variation in seed and nitrogen rates.* Field trials will be established in direct seeded fields to test the variable response of soft white winter wheat varieties to seeding density and nitrogen fertilizer rates. Three sites will be examined in northern Idaho, one location on the Palouse south of Moscow, the second on the Camas prairie near Reubens and a third site near Cavendish. A standard seeding rate of one million plants per acre will be used for seeding rate along with 0.6 and 0.8 million plants per acre. Six nitrogen rates will be used, with the control being based on pre-plant soil testing and the northern Idaho fertilizer guide at 2.5 lb N per expected bushel of grain. Additional rates will include 0 lb N/bu, 1.5 lb N/bu (60%), 2.0 lb N/bu (80%), 3.0 lb N/bu (120%) and 3.5 lb N/bu (140%). For each seeding and nitrogen rate combination, six varieties of soft white winter wheat will be evaluated. These varieties will include SY-Ovation, LCS Artdeco, LCS Drive (LWW12-7105), UI/WSU Huffman (IDN03-29902A), IDN01-10704A and IDN02-29001A. The trial will consist of five

replicates. During the growing season, the trials will be evaluated for plant stand and number of heads. Yield components will consist of total grain yield per plot, test weight, grain protein, head count per unit area, and 1000 kernel weight. Samples from each fertilizer rate will be sent to the wheat quality lab in Aberdeen, ID for baking analysis.

2. *Economic analysis of nitrogen rates.* The economics of each nitrogen rate by seeding rate by variety interaction will be calculated for each location. The cost of nitrogen, seed, commodity price, and discounts or premiums for protein will be taken into account. This information will be used to help determine the optimal nitrogen rates for each variety and location.

DURATION: During the 2015-2016 growing season, modifications were made by adding a third location and additional nitrogen rates. This project is currently moving into its third year and it is anticipated that it will be completed after the third season.

COOPERATION: Christopher Rogers, Assistant Professor in Aberdeen, will assist with the nitrogen rate study. Norm Ruhoff, Assistant Professor of Agricultural Economy in Moscow, will assist with the economic analysis of nitrogen and seeding rates. This project will involve grower cooperation to either host plots or in the case of the variable rate seeding, actively participate in establishing research plots and providing productivity history of the study site. This project also is being conducted in collaboration with Limagrain Cereal Seed who is supporting a graduate research position to fund the Master's graduate student who is working on these projects.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:

Variety specific information on seed and nitrogen fertilizer rates may improve the yield potential and profitability of some wheat varieties. It will also allow growers to more precisely manage their inputs and maximum their return on investment in seed and nitrogen fertilizer. Having information on new varieties will also potentially add value to product information when new varieties are released to the public from the University of Idaho/Limagrain Cereal Seed collaborative effort. The information may be used to develop protocols for identifying best agronomic practices to use for new variety releases in the future. The results of this project will be presented at the Cropping Systems Conference in Kennewick.

LITERATURE REVIEW: Fertilizer recommendations have been established for winter wheat production in northern Idaho (Mahler 2007). This guide is an excellent reference for estimating the nitrogen needs for a soft white winter wheat crop. Previous research has shown that varieties can differ in their nitrogen use efficiency (Ortiz-Monasterio et al. 1997, Barraclough et al. 2010, Gaju et al. 2011). With the cooperative agreement in place between the University of Idaho and Limagrain Cereal Seeds, a large number of new entries of European origin are available and being evaluated in northern Idaho. Several varieties are likely to be released for use in the Pacific Northwest due to high yields and optimal performance (Finkelburg and Schroeder 2013). It is possible that differences in nitrogen use efficiency may exist within these materials. Along with nitrogen use efficiency, optimal seeding rates may also vary between varieties. Previous work has examined genotype by seeding rate interactions (Freeze and Bacon 1990, Bavec et al 2002, Geleta et al 2002, Cima et al 2004). In many cases, the environmental variability was much greater than the variation in seeding rate. However, in some cases, there are reports of significant variety by seeding rate interactions (Freeze and Bacon 1990, Bavec et al. 2002). Although previous research has been conducted to optimize yield for many of these variables, new wheat varieties might have

the potential to be more efficient users of nitrogen fertilizer or may perform better using alternative seeding rates. Little research has been conducted in the northern Idaho with regard to the response of modern varieties to seeding or nitrogen rate. While little information is available in the literature with regard to variable rate seeding in winter wheat, this technology has been studied and adapted for other crops.

REFERENCES:

Barracough, P.B., Howarth, J.R., Jones, J., Lopez-Bellido, R., Parmar, S., Shepherd, C.E., and Hawkesford, M.J. 2010. Nitrogen efficiency of wheat: Genotypic and environmental variation and prospects for improvement. *Eur. J. Agronomy* 33:1-11.

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Del Cima, R., D' Antuono, M.F., and Anderson, W.K. 2004. The effects of soil type and seasonal rainfall on the optimal seed rate for wheat in Western Australia. *Aust. J. Exp. Agric.* 44:585-594.

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Geleta, B., Atak, M., Baenziger, P.S., Nelson, L.A., Baltenesperger, D.D., Eskridge, K.M., Shipman, M.J., and Shelton, D.R. 2002. Seeding rate and genotype effect on agronomic performance and end-use quality of winter wheat. *Crop Sci.* 42:827-832.

Mahler, R.L. 2007. Northern Idaho fertilizer guide: winter wheat. University of Idaho, Current Information Series 453.

Ortiz-Monasterio, J.I., Peña, R.J., Sayre, K.D., and Rajaram, S. 1997. Genetic progress in wheat yield and nitrogen use efficiency under four N rates. *Crop Sci.* 37:898-904.

IDAHO WHEAT COMMISSION - BUDGET FORM

Allocated by Idaho Wheat Commission during FY 2016 \$ 9,930

Allocated by Idaho Wheat Commission during FY 2017 \$ 9,738

REQUESTED FY2018 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	Graduate Tuition/Fees	TOTALS
Idaho Wheat Commission	\$ -	\$ 6,000	\$ 120	\$ 1,500	\$ 2,600	\$ -	10,220

TOTAL BUDGET REQUEST FOR FY 2018: \$ 10,220

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	(PI name)	(PI name)	(PI name)	(PI name)
Salary	\$ -	\$ -	\$ -	\$ -
Temporary Help	\$ -	\$ -	\$ -	\$ -
Fringe Benefits	\$ -	\$ -	\$ -	\$ -
Travel	\$ -	\$ -	\$ -	\$ -
Operating Expenses	\$ -	\$ -	\$ -	\$ -
Graduate Student Tuition/Fees	\$ -	\$ -	\$ -	\$ -
TOTALS	\$ -	\$ -	\$ -	\$ -

Total Sub-budgets \$ -

Explanatory Comments: (see FY2018 Guidelines for definition)

11.21.2016 - Version

ANNUAL REPORT

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ACCOMPLISHMENTS:

Field trials were established at three locations in the fall of 2015 to examine varietal response to varying nitrogen and seeding rates. The locations included a site north of Genesee, a site near Reubens on the Camas prairie and a site in Cavendish. At each location, six winter wheat varieties were seeded using six nitrogen rates and three seeding rates (0.6 to 1 million seeds/A). The nitrogen rates are based on the north Idaho fertilizer guide for soft white winter wheat. The standard rate of 2.5 lb nitrogen/bu expected yield was used as well as 0, 1.5, 2.0, 3.0 and 3.5 lb nitrogen/bu. The varieties included SY-Ovation, LCS Artdeco, LCS Drive (LWW12-7105), UI/WSU Huffman (IDN03-29902A), IDN01-10704A and IDN02-29001A. Mid-season a plant sample was collected for determining the number of tillers per plant. Near the end of the growing season each plot was evaluated for the number of heads per meter. Harvest data included yield, test weight, mature plant height and protein. Grain samples were collected from four replications for each variety by nitrogen rate combination. The samples are being processed by the wheat quality lab in Aberdeen, ID for flour and baking quality.

Trials were successfully completed at all three locations. Based on overall yields across all six varieties, seeding rate does not appear to be a major factor related to yield. One million plants per acre is the standard seeding rate for winter wheat in many regions of northern Idaho and reducing the seeding rate to 0.6 or 0.8 million seeds per acre did not significantly impact yield with the exception of Reubens. Grain protein was not consistently impacted by seeding rate. Despite very little reduction in yield, the higher seeding rate is preferred to provide better competition with weeds. Decreasing or increasing nitrogen rates from the standard rate of 2.5 lb nitrogen per bushel of expected yield resulted in significant shifts in yield at all locations. The rate of 3.5 lb nitrogen per bushel of expected yield resulted in the highest yield at all locations. The distribution by nitrogen rate is shown by variety for Reubens and Genesee. Most varieties continued to positively respond to increasing nitrogen rates, even at 140% of recommended rates. At both of these locations, LCS Artdeco reached a maximum yield around 120% of normal nitrogen rate, while varieties such as IDN-01-10704A and UI-WSU Huffman increased substantially in yield at Genesee when 140% of the normal nitrogen rate was applied. Precipitation for the 2015-2016 season was slightly above normal, but due to timely rainfall in late spring and early summer, plants were able to maximize yield due to optimal growing conditions. In applying cost of inputs and economic returns based on yield for these treatments, the optimal rate of fertilizer is being determined for each variety. For example, based on 2016 values, the optimal nitrogen rate for SY Ovation would be 98% at Genesee and 128% at Reubens. This is similar to the rates calculated

for the previous growing season which were 99% for Genesee and 104% for Reubens. After collection of data from the 2016-2017 growing season, a more robust analysis and estimation of optimal nitrogen rates will be calculated for the six varieties included in all three years of this study.

Yield data for varietal response to nitrogen and seeding rates in Genesee, 2016.

Seeding Rate (seeds/A)	Yield (bu/A)	Grain Protein (%)	Nitrogen Fertilizer Rate (lb/bu expected yield)	Yield (bu/A)	Grain Protein (%)
600,000	96.8	9.6 ab	0.0	71.6 f	9.4 cd
800,000	94.3	9.5 b	1.5	79.8 e	9.5 bd
1,000,000	96.3	9.7 a	2.0	93.0 d	9.2 d
			2.5	101.8 c	9.6 bc
			3.0	110.5 b	9.7 b
			3.5	117.8 a	10.1 a

Yield data for varietal response to nitrogen and seeding rates in Reubens, 2016.

Seeding Rate (seeds/A)	Yield (bu/A)	Grain Protein (%)	Nitrogen Fertilizer Rate (lb/bu expected yield)	Yield (bu/A)	Grain Protein (%)
600,000	73.4 b	7.8	0.0	69.3 bc	7.7 b
800,000	75.7 a	7.7	1.5	64.4 c	7.7 b
1,000,000	76.6 a	7.7	2.0	69.6 bc	7.8 ab
			2.5	73.3 b	7.6 b
			3.0	85.8 a	7.8 ab
			3.5	88.9 a	7.9 a

Yield data for varietal response to nitrogen and seeding rates in Cavendish, 2016.

Seeding Rate (seeds/A)	Yield (bu/A)	Grain Protein (%)	Nitrogen Fertilizer Rate (lb/bu expected yield)	Yield (bu/A)	Grain Protein (%)
600,000	59.2	7.5 b	0.0	48.8 d	7.8 a
800,000	59.6	7.6 a	1.5	51.2 d	7.7 a
1,000,000	59.4	7.5 ab	2.0	54.0 cd	7.7 a
			2.5	60.2 c	7.5 b
			3.0	66.9 b	7.4 b
			3.5	75.5 a	7.4 b

The second part of this project was to examine variable rate seeding. A site was established in a commercial field near Craigmont, ID in collaboration with a grower cooperator in the fall of 2015. The cooperators are currently employing variable rate nitrogen applications, so strips were orientated to pass through each of three distinct zones that were designated as low, moderate or high yield potential. Strips (50 feet wide) were seeded across the field (approximately 2,000 ft) with SY-Ovation at rates of 0.25, 0.5, 0.75 and 1 million seeds per acre. Typical seeding rates in this area are about 0.8 million seeds per acre. At each of 96 georeferenced locations across the field, stand counts were verified in the spring. At harvest, total biomass samples were collected from a 2 m² portion of the field at each of the control points. Head counts were also made within each of these control points to that the harvest index can be determined. Data from this trial is being compiled and was not available in time for this report. Summaries will be available in future reports.

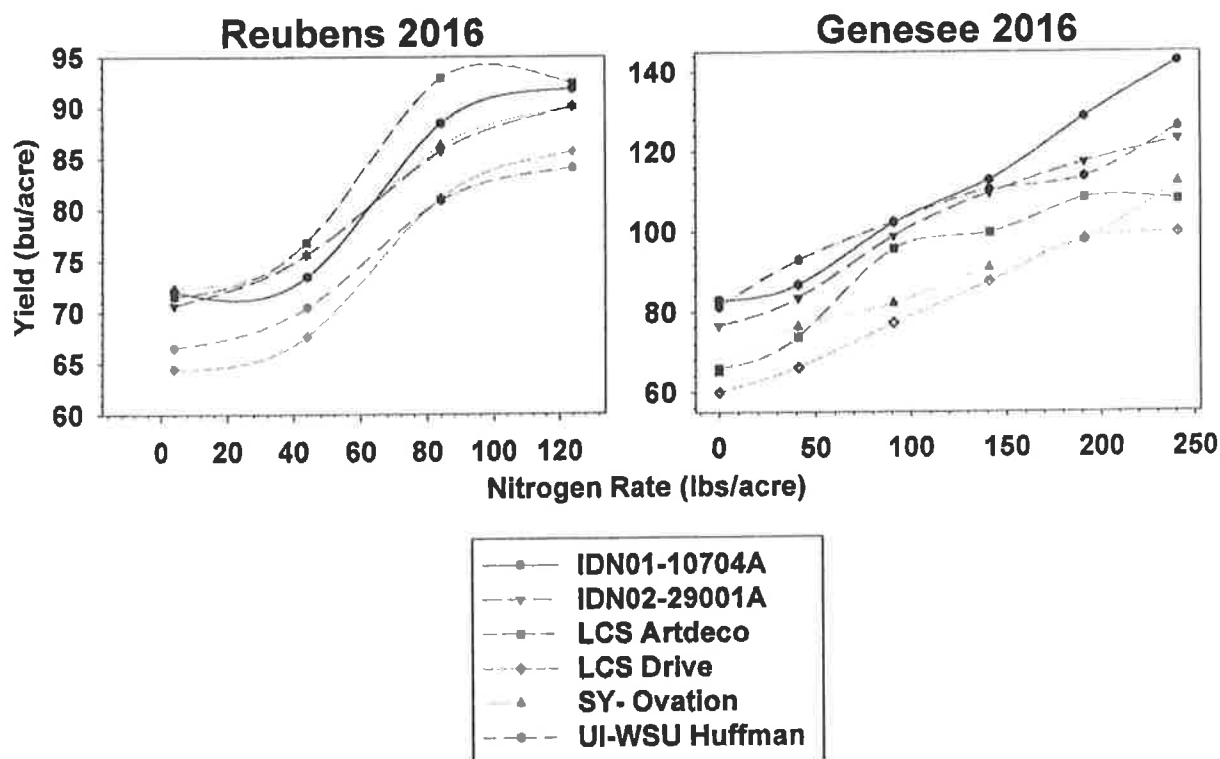


Figure 1. Yield for the 2015-2016 growing season by nitrogen rate expressed as percentage of average nitrogen rate (2.5 lb N per bushel expected yield).

The study to evaluate seeding rate by nitrogen rate was reseeded at Cavendish, Genesee and Reubens in the fall of 2016. The varieties continue to include SY-Ovation, LCS Artdeco, LCS Drive (LWW12-7105), UI/WSU Huffman (IDN03-29902A), IDN01-10704A and IDN02-29001A.

PROJECTIONS:

Data will be collected from these studies during the summer of 2017 as was described for the previous year's study. It is anticipated that data collected from this study will be used to generate a research publication as well as serve as the basis for future work related to nitrogen research and varietal responses. Results of this research will be shared at the Cropping Systems conference in Kennewick, WA.

PUBLICATIONS:

Senefsky, C., and Schroeder, K. L. 2016. Exploring varietal response of soft white winter wheat to nitrogen and seeding rates in northern Idaho. ASA-CSSA-SSSA annual meeting, Nov. 6-9, Phoenix, AZ.

Senefsky, C., White, D., and Schroeder, K. 2016. Varietal response of soft white winter wheat to nitrogen fertilizer and seeding rate. Pp. 59-60. In: *2016 Dryland Field Day Abstracts: Highlights of Research Progress*. Idaho Agricultural Experiment Station, Research Bulletin 189.