PROJECT NO: BJKU57

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

PERSONNEL: Dr. Kurtis L. Schroeder, Assistant Professor of Cropping Systems Agronomy
Mr. Cole Senefsky, M.S. Graduate Research Assistant

ADDRESS: Plant, Soil and Entomological Sciences Department, University of Idaho, 875 Perimeter Drive MS 2339, Moscow, ID 83844-2339; 208-885-5020; kschroeder@uidaho.edu

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 reexamine seeding rates and nitrogen rates with respect to variety, with a focus on evaluating varieties from the University of Idaho (adapted to north Idaho growing conditions) and varieties of European origin that have been introduced into the inland Pacific Northwest in recent years.

In addition to knowing a specific seeding rate of a variety, there is desire to understand how changes in seeding densities across a field may improve productivity. Other precision or variable rate technologies have been studied and some are being incorporated into farming practices, namely variable rate nitrogen application. Using yield maps and soil testing, prescription fertilizer applications can be made, applying less fertilizer in lower yielding areas and more nitrogen fertilizer in highly yielding areas. The net result is a reduction in nitrogen application or a reallocation of the same quantity of nitrogen in a field to produce higher yields. Newer drills have the capability of seeding rate adjustment while in operation, making variable rate seeding practical. In addition, some growers often observe portions of their fields that are poor in productivity due to soil erosion or shallow soils. Reduced seeding rates targeted to specific areas within fields may help to prevent plants from becoming stressed later in the season and result in increased yields. Examining the utility of variable rate seeding of wheat may provide an additional tool for growers to manage limited environmental resources. The goal is to provide preliminary data to aid in developing models for variable seeding rates in northern Idaho.

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. Test the feasibility of variable rate seeding for winter wheat and provide preliminary data to support developing a model for implementing variable rate seeding.

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, Haun ratings will be collected in early June to assess plant development, and yield components will consist of total grain yield per plot, test weight, grain protein, head count per unit area, and 1000 kernel weight.

2. *Variable seeding rates using precision tools.* Variable rate seeding will continue to be examined on a grower field, using a commercial seed drill equipped with variable rate technology. Field trials will be established with a cooperator on the Camas prairie near Nezperce. The cooperator has multiple years of detailed yield map data and on the ground knowledge of productivity across the field. The cooperators are currently employing variable rate nitrogen applications and generally seeds at about 0.8 million seeds per acre. Strips (50 feet wide) will be seeded across the field with SY-Ovation at rates of 0.5, 0.67, 0.83 and 1 million seeds per acre. Each seeding rate will be replicated four times. The strips will be oriented in the field so that each passes through each of three zones that will be designated as 'low', 'moderate' (average) and 'high' yield potential. Within each strip, control points will be georeferenced for detailed analysis. At each of these 96 locations, stand counts will be collected to verify seeding density. At harvest, 1 m x 2 m sections will be harvested by hand to estimate yield, calculate harvest index and grain protein. An additional 0.5 m row will be sampled to determine the number of spikes per unit area, kernels per spike and 1000 kernel weight. Strips will then be harvested by a commercial combine, mapping yield across each strip.

DURATION: With modifications made to the varietal response to nitrogen and fertilizer, this is being expanded from a 2 year to a 3 year study. The repeat of these studies was seeded in the fall of 2015 and the third year of the study will be seeded in the fall of 2016. A preliminary analysis of the data will be completed during the winter of 2016/2017.

COOPERATION: Christopher Rogers, Assistant Professor in Aberdeen, will assist with the nitrogen rate study. 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. Results from the variable rate seeding study will help in developing models and recommendations for using this technology. This study will serve as a pilot study to examine the feasibility of using variable rate seeding. When possible and appropriate, the results of this study will be shared at field days, winter cereal schools and meetings, popular press articles and a peer-reviewed publication. Preliminary results of this study will be presented at the Cropping Systems Conference in Kennewick as well as the American Society of Agronomy annual meeting in the fall of 2016.

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 (Finkelnburg 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:
Barraclough, 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.

Bavec, M., Bavec, F., Varga, B., and Kovačević, V. 2001. Relationship among yield, it's quality and yield components in winter wheat (Triticum aestivum L.) cultivars affected by seeding rates. Die Bodenkultur 53:143-151.

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.

Finkelnburg, D., and Schroeder, K. 2014. 2013 Small grain and grain legume report. University of Idaho, Research Bulletin 184.

Freeze, D.M., and Bacon, R.K. 1990. Row-spacing and seeding-rate effects on wheat yields in the mid-south. J. Prod. Agric. 3:345-348.

Gaju, O., Allard, V., Martre, P., Snape, J.W., Heumez, E., LeGouis, J., Moreau, D., Bogard, M., Griffiths, S., Orford, S., Hubbart, S., and Foulkes, M.J. 2011. Identification of traits to improve the nitrogen-use efficiency of wheat genotypes. Field Crop Research 123: 139-152.

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 2015	$	-
Allocated by	Idaho Wheat Commission	during FY 2016	$	9,930

REQUESTED FY 2016 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	Graduate Tuition/Fees	TOTALS
Idaho Wheat Commission	$ -	$ 5,500	$ 138	$ 1,500	$ 2,600	$ -	$ 9,738

OTHER RESOURCES (not considered cost sharing or match):

TOTAL OTHER RESOURCES	$	-

TOTAL PROJECT ESTIMATE FOR FY 2017:	$ 9,738 *(Requested)*	$ 27,050 *(Other)*	$ *(Total)*	36,788

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	$	-

10.7.2015 - Version

ANNUAL REPORT

PROJECT NO: BJKU57

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

PERSONNEL: Dr. Kurtis L. Schroeder, Cropping Systems Agronomist, Moscow
Cole Senefsky, MS Graduate Student, Moscow

ADDRESS: Kurtis L. Schroeder: Plant, Soil and Entomological Sciences Department, University of Idaho, 875 Perimeter Drive MS 2339, Moscow, ID 83844-2339; 208-885-5020; kschroeder@uidaho.edu

ACCOMPLISHMENTS:

Field trials were established at two locations in the fall of 2014 to examine varietal response to varying nitrogen and seeding rates. The two locations included a site north of Genesee and a second site near Reubens, ID on the Camas prairie. At each location, four winter wheat varieties were seeded using four 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 1.5, 2.0 and 3.0 lb nitrogen/bu. The varieties included Brundage 96, SY-Ovation, LCS Artdeco, LCS Biancor, LWW10-1073, LWW12-7105, UI/WSU Huffman (IDN03-29902A), IDN01-10704A, IDN02-29001A, and UI Magic (09-DH11). A mid-season assessment of plant maturity was recorded (Haun ratings) along with harvest data in the fall of 2015. Harvest data included yield, test weight, mature plant height and protein.

While detailed analysis of the specific varietal interactions with fertilizer rate and seeding rate are still ongoing, below is a summary of observed responses. The overall plots yields were 110 and 76 bu/A for Genesee and Reubens, respectively. Based on overall yields across all 10 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 only slightly reduced yield. It is unlikely that there will be significant varietal responses to seeding rate. Despite very little reduction in yield, the higher seeding rate is preferred to provide better competition with weeds. However, there was a response to decreasing or increasing nitrogen rates from the standard rate of 2.5 lb nitrogen per bushel of expected yield at both Genesee and Reubens. With increasing nitrogen rate, the average yield increased with the exception of the highest fertilizer rate at Reubens. Due to the unusually warm conditions in late June, yields at most locations on the Camas prairie were reduced. With the heat stress and dry conditions, plants at Reubens were likely not able to use the extra nitrogen applied. Additional analyses are now underway to determine whether there are differences in varietal response to nitrogen. An important factor to consider with increasing the nitrogen rates above the standard recommended rate is the potential for increasing the protein of soft white winter wheat to an undesirable level. Protein is currently being measured and will be used as a component of the analyses.

The second part of this project was to examine variable rate seeding. A site was established in a commercial field near Winona, ID on the Camas prairie in collaboration with a grower cooperator

Yield data for varietal response to nitrogen and seeding rates (Genesee).

Seeding Rate (seeds/A)	Yield (bu/A)	Nitrogen Fertilizer Rate (lb/bu expected yield)	Yield (bu/A)
600,000	107.8	1.5	95.7
800,000	107.3	2.0	108.5
1,000,000	113.8	2.5	114.2
		3.0	119.7

Yield data for varietal response to nitrogen and seeding rates (Reubens).

Seeding Rate (seeds/A)	Yield (bu/A)	Nitrogen Fertilizer Rate (lb/bu expected yield)	Yield (bu/A)
600,000	76.0	1.5	62.8
800,000	76.7	2.0	75.5
1,000,000	77.3	2.5	84.0
		3.0	84.1

in the fall of 2014. 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 m^2 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. Grain yield will be determined for each of these sites and compared with yield data collected by the harvest monitor used in the field. These samples are still being processed and summaries will be available in future reports.

Both of the above studies were reseeded in the fall of 2015. For the varietal response to nitrogen and seeding rates, the number of varieties was reduced to accommodate additional nitrogen rates as well as to help control natural variation due to the size of the plot. The varieties retained for the 2015/2016 growing season include SY-Ovation, LCS Artdeco, LWW12-7105, UI/WSU Huffman (IDN03-29902A), IDN01-10704A and IDN02-29001A. The additional nitrogen rates include 0 lb of added nitrogen to allow for the direct measurement of the efficiency of applied nitrogen and 3.5 lb nitrogen per bushel of expected yield. The study was also expanded to a third location in Cavendish which represents a unique environment in northern Idaho. The seeding rate study was also reseeded with the same grower cooperators as described above. The trial site in near Nezperce for the 2015/2016 growing season.

PROJECTIONS:

Data will be collected from these studies during the summer of 2016 as was described for the previous year's study. It is anticipated that the varietal response to nitrogen and seeding rate study will be repeated again in the 2016/2017 crop season to have two complete years of data for the additional nitrogen rates and location. Preliminary data from this work will be presented at the

Cropping Systems conference in Kennewick, WA as well as the American Society of Agronomy annual meeting in 2016.

PUBLICATIONS:
None