**PROJECT NO:** New

**TITLE:** Exploring the feasibility of using high lime rates on crop performance in northern Idaho and examining the impact of liming and soil pH on soilborne pathogens of wheat

**PERSONNEL:** Dr. Kurtis Schroeder, Assistant Professor of Cropping Systems Agronomy
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**JUSTIFICATION:** Soil pH is declining in northern Idaho due mainly to the long-term use of ammonium-based nitrogen fertilizers. The parent soils in many regions of northern Idaho are forest-derived, which means they have a lower starting pH and lower buffering capacity, making them more susceptible to changes in pH. Acidification of soils in northern Idaho and eastern Washington was well documented during the 1980's by Dr. Mahler at the University of Idaho. A recent survey revealed that soils have continued to decline in pH, with the majority of northern Idaho fields having a pH below 5.5 in the upper 6 inches (Schroeder and Finkelnburg, unpublished). Furthermore, 34% of fields sampled were below a pH of 5. These soils are at risk of or are experiencing aluminum toxicity and remediation by liming is necessary. While other solutions include growing aluminum-tolerant crops or planting aluminum-tolerant wheat, these strategies limit options for diverse rotations and may not be adequate solutions for some fields that are experiencing more serious pH issues. Previous research to compare liming products and rates of up to 1 ton lime/A revealed that liming will improve soil pH, reduce soluble aluminum quantities in the soil and improve yield (Schroeder et al, unpublished). Unfortunately, improved crop performance was not observed at all locations and the rates used were well below the lime requirement rates calculated from soil tests. There is a need for testing using higher rates of lime and determining the economic feasibility of such treatments. In addition, soil pH can impact plant pathogen populations and a classic example is *Cephalosporium gramineum* being favored by acid soil conditions. Preliminary studies suggest that soil pH may also influence other pathogens such as *Fusarium* spp. and *Rhizoctonia* spp. Knowledge about the impact of soil liming on diseases could be an added benefit of liming.

**HYPOTHESIS AND OBJECTIVES:** The hypotheses are that application of higher rates of calcium carbonate will incrementally increase soil pH and will more likely result in a significant improvement in yield. Secondly, the cost of applying higher rates of lime will be offset by a more durable and substantial shift in soil pH and increases in yield over multiple years. Third, lime will decrease the severity and/or incidence of root and crown diseases. Specific objectives are to:

1) Establish liming trials at five locations in norther Idaho to explore lime rates up to 3 ton/A.
2) Examine the impact of soil pH on cereal pathogens, focusing on root and crown diseases.

**PROCEDURES:**

1. *Crop response to calcium carbonate application.* In the fall of 2016, additional liming studies were established at a four locations in northern Idaho to evaluate higher rates of lime based on the lime requirement tests. A fifth site will be established in the spring of 2017. The current sites include locations near Potlatch and Tensed, ID. Many soils that have been surveyed over the past couple of years could require up to 4 to 5 tons of calcium carbonate per acre to return the soil to a pH of 6 in the upper 12 inches. Liming treatments consist of ground limestone

(Pioneer Enterprises, Lewiston, ID) applied at rates of 1, 2 and 3 ton/A along with a no lime control. After liming, the material was incorporated to a depth of 4 to 6 inches. Each treatment is replicated four times at each location and each individual plot is 8 ft wide by 100 ft long. Winter wheat cultivar UI-WSU Huffman was seeded into three of the four sites. The other two locations will be seeded in the spring of 2017 to match the crop rotation in each field. In mid to late May, samples will be collected from each plot to a depth of 30 cm to monitor changes in the soil pH. Samples will be collected from 0-7.5 cm, 7.5-15 cm, 15-22.5 and 22.5-30 cm. Plots will be evaluated to assess plant damage due to acid soil and/or aluminum toxicity. As the opportunity arises, diseases will be assessed in these trials to identify any differential response of the pathogens. At the end of the growing season, each plot will be harvested. Yield information will be used to generate an economic analysis of the lime application over the course of the study

2. *Impact of soil pH on root and crown diseases.* The impact of soil pH on the incidence and severity of root and crown diseases will be examined under greenhouse conditions and field. Soils will be collected from various sites on the Parker Farm in Moscow, ID that have soil pH from 4.0 to 6.0. Calcium carbonate will be added to portions of these soils to increase pH and soils will be inoculated with *Fusarium culmorum*, *F. pseudograminearum*, *Rhizoctonia solani*, and *R. oryzae*. After 3 to 4 four weeks, plants will be destructively harvested; disease incidence and severity scored; and first leaf length, plant height and dry plant weights recorded. Afield trial will be established at the Parker farm to examine the impact of soil liming and subsequent change in soil pH on Fusarium crown rot. A portion of a field with a pH of approximately 4.2 will be limed using NuCal fluid lime. Into this field will be planted spring wheat, with half of the plots containing inoculum of *Fusarium culmorum*. Plots will be evaluated for disease at tillering (about 6-7 weeks after planting) and again after harvest by evaluating the lower stem and crown tissue. If white heads are apparent later in the growing season, plots will also be evaluated for the incidence of this symptom. Plots will be harvested to obtain grain yield, test weight and protein.

**DURATION:** This liming project to examine higher rates of lime is expected to run for at least 6 years. The interaction of soil pH and plant diseases is anticipated to be a 2 year project.

**COOPERATON:** Research plots will be conducted on University of Idaho research farms in Moscow and in cooperation with local growers in Potlatch, ID; Tensed, ID; and a third region to be identified (Troy/Genesee area or Camas Prairie). As multiple years of data are collected, an agricultural economist will be brought onto the project to assist with the economic analysis.

**ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:** Results of this study will provide information on the potential benefit and strategies for using higher rates of lime that are close to recommended lime rates. The benefits of liming include the potential for improved yields, greater plant available nitrogen, improved microbial activity, reduced plant disease, and increased profitability over time. This study will provide growers with information on how best to apply lime to their operations and highlight additional advantages of improving soil health and reducing disease. The results of this study will be shared at field days and winter cereal schools.

**LITERATURE REVIEW:** Acidification of soils in northern Idaho was well documented during the 1980's by Dr. Mahler at the University of Idaho. As part of his research, the critical soil pH levels for pea, lentil, barley and wheat were determined, varying between a pH of 5.2 to 5.6

(Mahler and McDole 1987). There is renewed interest in this topic due to continued acidification and the discovery of associated acute aluminum toxicity in some areas of Spokane Co. in eastern Washington (Koenig et al. 2011). A recent survey of soils in northern Idaho revealed that soil pH is continuing to decline and that 34% of the 116 fields surveyed had a soil pH below 5 and average soluble aluminum concentrations of 53 ppm (Schroeder and Finkelnburg, unpublished). Recent research in Washington State into the use of liming did not demonstrate an improvement in yield (Brown et al. 2008). However, the soils examined in this particular study were in soils historically covered by grass vegetation and have a high non-acid base saturation, preventing high quantities of aluminum from impacting plant health. In a separate study, winter wheat seeded into limed soils that had an initial pH below 5 and soluble aluminum in the upper 6 inches responded to lime application at 2 of 3 locations (Schroeder et al, unpublished). Likewise, Mahler and McDole (1985) demonstrated an increase in yields following lime application to field that were historically forested. Very little information exists on the impact of pH on Rhizoctonia root rot, *Pythium* spp. are known to be favored by slightly acidic conditions (5.0-5.5), and information on the impact of pH on Fusarium crown rot is mostly limited to studies examining ammonium versus nitrate forms of fertilizer, although Fusarium wilt diseases on other host crops are known to be favored by acidic conditions (Kirby et al 2017).

Brown, T.T., Koenig, R.T., Huggins, D.R., Harsh, J.B., and Rossi, R.E. 2008. Lime effects on soil acidity, crop yield and aluminum chemistry in direct-seeded cropping systems. Soil Science Society of America Journal 72:634-640.

Kirby, E. M., Paulitz, T. C., Murray, T. D., Schroeder, K. L., and Chen, X. M. 2017. Disease Management for Wheat and Barley. In: Yorgey, G. and C. Kruger, eds. Advances in Sustainable Dryland Farming in the Inland Pacific Northwest, Washington State University Extension, Extension Publication EM108. (accepted)

Koenig, R., Schroeder, K., Carter, A., Pumphrey, M., Paulitz, T., Campbell, K., and Huggins, D. 2011. Soil acidity and aluminum toxicity in the Palouse region of the Pacific Northwest. Washington State University, Extension Bulletin FS050E.

Mahler, R.L., and McDole, R.E. 1985. The influence of lime and phosphorus on crop production in northern Idaho. Communications in Soil Science and Plant Analysis 16:485-499.

Mahler, R.L., and McDole, R.E. 1987. Effect of soil pH on crop yield in northern Idaho. Agronomy Journal 79:751-755.

## IDAHO WHEAT COMMISSION - BUDGET FORM

| | | | | |
|---|---|---|---|---|
| Allocated by | Idaho Wheat Commission | during FY 2016 | $ | - |
| Allocated by | Idaho Wheat Commission | during FY 2017 | $ | - |

**REQUESTED FY2018 SUPPORT:**

| | Salary | Temporary Help | Fringe | Travel | OE | Graduate Tuition/Fees | TOTALS |
|---|---|---|---|---|---|---|---|
| Idaho Wheat Commission | $ - | $ 6,000 | $ 120 | $ 1,600 | $ 6,800 | $ - | $ 14,520 |

**TOTAL BUDGET REQUEST FOR FY 2018:** $ 14,520

**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*