

## IMPROVING NITROGEN MANAGEMENT FOR CORN IN SOUTHERN IDAHO AND SOUTHWEST OREGON

David Tarkalson<sup>1</sup>, Dave Bjorneberg<sup>1</sup>, Amber Moore<sup>2</sup> and Steven Hines<sup>3</sup>

<sup>1</sup> USDA-ARS Northwest Irrigation and Soils Research Laboratory, Kimberly, ID

<sup>2</sup> University of Idaho, Twin Falls Research and Extension Center, Twin Falls, ID

<sup>3</sup> University of Idaho, Jerome County Extension, Jerome, ID

### ABSTRACT

Funding is being sought from multiple sources to update nitrogen (N) fertilizer recommendations for irrigated corn in southern Idaho and southwest Oregon. This paper summarizes the justifications and main objectives of this proposed research.

Nitrogen needs to be correctly managed in corn production systems to optimize economic returns and to protect the environment. The fertilizer N recommendations for irrigated field corn in Idaho and other parts of the Pacific Northwest (PNW) need to be re-evaluated because: (1) University of Idaho (U of I) and PNW region recommendations are based on sparse research data; (2) Recommendations are based on research data that is over 25 years old; (3) Corn production area and yield have increased dramatically in concentrated areas due to the growing dairy industry; (4) There is evidence of variation in optimal N rates and management between the U of I recommendations and growers, and between U of I and other corn growing regions; (5) In southern Idaho nitrate (NO<sub>3</sub>) concentrations have been increasing in groundwater and springs along the Snake River. Agriculture has been implicated by the Idaho Department of Environmental Quality as a major source of the NO<sub>3</sub>. This document elaborates on the above justifications.

### INTRODUCTION

#### **(1) The existing U of I recommendations are based on sparse research data:**

The U of I corn N fertilizer recommendations can be traced back to at least 1959 (Owens and Ensign, 1959). Owens and Ensign (1959) provide no reference to the research data used to establish the N fertilizer recommendations. The 1959 N recommendations were three rates (120, 100, and 90 lbs N/acre) each applied to one of three climatic growing zones in the state. The climatic zones were based on length of growing season and accumulated temperature during the growing season. Adjustments to the N rates were suggested based on previous crop and history of manure application, but no quantifiable adjustments were specified.

Later U of I corn N recommendations (Painter et al., 1977) incorporated a residual soil inorganic N concentration from a soil sample to guide N recommendations. Specific research data used to develop the recommendations were not published. However, Brown and Long (1987) stated that three research studies justified the use of soil testing as a basis for the recommendations (Nelson, 1966; Painter, 1964; Thiessen, 1972).

Brown and Long (1987) conducted a research study to evaluate the 1977 U of I corn N recommendations, specifically to determine the effects of yield potential and mineralizable soil N on corn N requirements. This study consisted of 13 site-years of data between 1971 and 1986. The data from this study resulted in the inclusion of a yield goal component into the current U of I corn N recommendations (Brown and Westermann, 1988). The study also validated the continued use of residual soil inorganic N testing to guide N fertilization. Brown and Long

(1987) is the only published and detailed study assessing N fertilization for corn in Idaho. Although valuable and still useful, the data set is extremely limited and needs to be expanded.

In 2010, The U of I, Oregon State University and Washington State University published inland PNW nutrient recommendations for corn (Brown et al., 2010). Based on conversations with the publications author, there was very little added data beyond the Brown and Long (1987) data set. Thus the inland PNW area could benefit from added research to evaluate N recommendations for corn.

Idaho and other parts of the PNW have extremely limited data for corn N recommendations compared to other locations. For example, Nebraska corn N recommendations are based on 113 site years of data. The importance of updating and expanding N recommendations was illustrated in Nebraska. In early 2002, University of Nebraska corn N recommendations were based on 81 site-years of data, with the newest data set collected 25 years before. The state of Nebraska allocated \$300,000 to update the nutrient recommendations (N, phosphorus, potassium, and sulfur) for irrigated corn. As a result an additional 32 site years were added to the data set and valuable updates were made to make corn production more profitable and environmentally sustainable. The funding available for the study in Nebraska is not common; in most cases the limited availability of competitive funds for research on fertilizer recommendations has hampered regular updates of fertilizer recommendations. This has been the case in Idaho and other areas in the arid PNW where irrigation is required. As a result, it is hard to determine how to minimize fertilizer costs for growers and reduce N losses.

**(2) Recommendations are based on research data that is over 25 years old:**

The primary database for the U of I N fertilizer recommendations for corn is outdated (27 years). The age of the data is a valid justification for added research because: a) current corn yields are significantly greater than when the initial research was conducted, b) new hybrids may respond differently to N than hybrids used when the past studies were conducted, c) precision agricultural technology has advanced compared to when the past studies were conducted, and d) corn is now grown over a wider area with varying growing conditions. The last research data set used to update to the U of I N recommendations took place between 1971 and 1986 (Brown and Long, 1987).

**(3) Corn production area and yield has increased dramatically in concentrated areas due to the growing dairy industry:**

Corn production in the PNW has increased over time in response to the growing dairy cow populations. This is particularly true for south central Idaho, as the dairy cow population has increased from approximately 75,000 to 407,000 head from 1986 to 2009, the corn acreage has increased from approximately 20, 100 to 143,000 over the same time period (USDA-NASS). From 1983 to 2009 the average annual silage and grain yields have increased at an average annual rate of 0.3 tons/acre and 1.9 bu/acre, respectively; representing an average increase of 7.8 tons silage/acre and 49 bu grain/acre (USDA-NASS). With the emphasis on modern corn production in confined areas, robust and up-to-date irrigated corn N recommendations need to be established.

**(4) There is evidence of variation in optimal N rates and management between the U of I recommendations and growers, and between U of I and other corn growing regions:**

There are large differences in the corn N recommendations of the U of I and PNW with that of the more robust research based recommendations of the irrigated Midwest region of the U.S. (Nebraska, Kansas and Colorado; Figure 1). The data show that the U of I N recommendations are consistently higher than the other major irrigated corn states over most yield levels even when the average irrigated grain yields for these states are similar (181, 187, 182 and 186 bu/acre for Idaho, Nebraska, Kansas and Colorado, respectively, USDA-NASS). These data potentially indicate that N recommendations in Idaho are too high, or N recommendations are too low in other states, or N use efficiency in Idaho/PNW is lower than the other states. The University of Idaho recommendations were based mainly on furrow irrigated sites and most N was applied pre-plant. We assume that under current irrigation practices (increased sprinkler irrigation methods) and split applications of N fertilizers there will not be a large difference in Nitrogen Use Efficiency (NUE) between Idaho and other areas. However, without actual data to back up recommendations growers do not have confidence to adjust N application rates. Thus, improving our N response dataset in Idaho/PNW will lead to more precise N applications to optimize production and reduce negative environmental impacts.

Anecdotal evidence, based on conversations with a U of I Extension Educator suggest that many growers believe the U of I corn N recommendations are too low, and thus they apply N at comparatively greater rates.

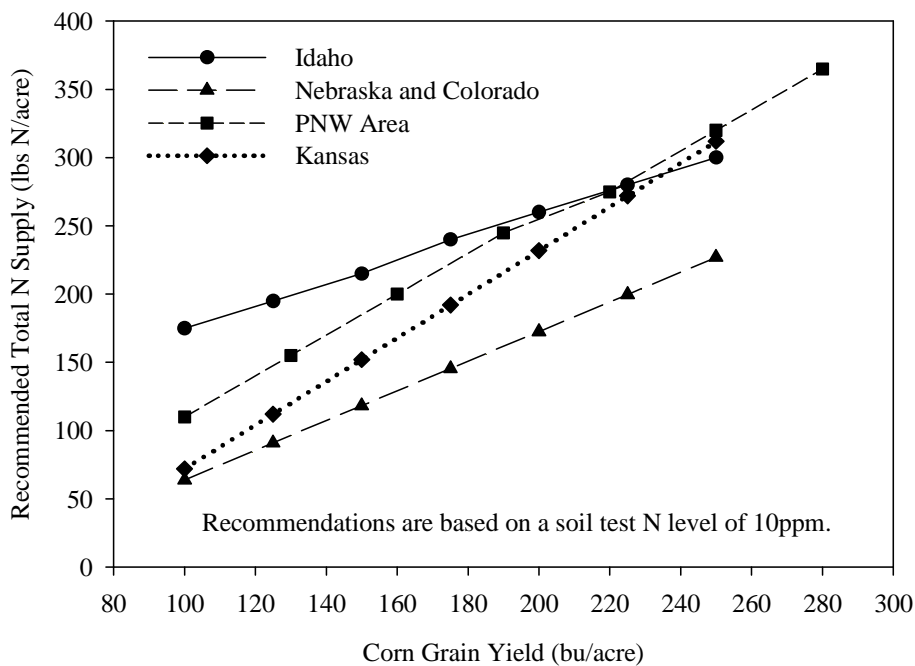


Figure 1. Comparison of State Corn Grain Nitrogen Supply Recommendations

**(5) In southern, Idaho NO<sub>3</sub> concentrations have been increasing in various springs along the Snake River:**

The Idaho Department of Environmental Quality produced a report in 2009 to identify potential NO<sub>3</sub> sources that are impacting groundwater and discharge springs entering aquaculture facilities and the Snake River. The groundwater of interest is part of the Eastern Idaho Snake River Plain Aquifer which is the drinking water source for 200,000 people in southern Idaho. The NO<sub>3</sub> concentrations in the springs have significantly increased over time (IDEQ, 2009). Isotope analysis and nutrient budgets identified a mixture of animal, human and commercial fertilizer as the sources of the NO<sub>3</sub>, with animal manures and commercial fertilizer supplying approximately 43 and 47% of the total N load on the land over the aquifer recharge area, respectively. A large proportion of the recharge area of concern contains a high population of dairy cattle and the corn grown for feed. Because of this, improving N management recommendations for corn could help reduce NO<sub>3</sub> leaching to the groundwater and springs.

**RESEARCH HYPOTHESIS**

Our null hypothesis is that existing U of I corn N recommendations are valid for high yields and will meet the needs of growers in the future. This hypothesis will be tested to the alternative one where the U of I corn N recommendations are not correct and further research is needed to improve the recommendations in order to optimize production and minimize environmental impacts. It is assumed that the current recommendations need to be improved in terms of rate of application, timing of application and source of N applied. Ideally, future recommendations in Idaho and other areas of the PNW would account for the climatic differences across the area, soil types, crop rotations, tillage practices and economic considerations.

**OBJECTIVES**

The goal of this research project is to improve irrigated corn N recommendations in Idaho and other areas of the PNW in order to increase N use efficiency, increase grower economic profitability, protect the environment and lead to a more sustainable agriculture industry. To accomplish this, the data will be used to develop new software tools for N management and be made available to private soil testing laboratories, fertilizer dealers and agronomy service companies to improve their management of N.

Specific objectives are to:

1. Verify or revise existing U of I/PNW N fertilizer recommendations for corn at current and future yield levels and cropping technologies.
2. Compare alternative application timing and N sources to conventional management with regard to production and potential environmental impacts.
3. Develop and distribute printed materials and software tools for improved N management to growers, industry personnel and government agencies.

**TREATMENTS AND EXPERIMENTAL DESIGN**

All experimental work will be conducted at 8 to 10 locations annually for 3 years, selected based on a climatic gradient (Magic Valley to Eastern Oregon) and major corn growing soil types (silt loams in Magic Valley located south of the Snake River, sandy soils located in Magic Valley north of the Snake River and silt loams in the Treasure Valley). Each year the research plot area will move to a different location within the same field or to a neighboring field. All

sites will be on irrigated land, either sprinkler or furrow irrigation. Sites will be selected that have not had manure applied in the previous 3 years.

The main treatments will be composed of incrementing increasing rates ( $\approx 5$  rates) of N fertilizer (0 to 300 lbs N/acre). Additional treatments consisting of application timing and controlled release N sources will be included. The protocols in this study will be designed to ensure as little disruption to grower operations as possible. The total study area needed at each site will be between 1 and 1.5 acres.

## CONCLUSION

Armed with these improved principles for N management, we will improve irrigated corn N recommendations in Idaho and other areas of the PNW in order to increase N use efficiency, increase grower economic profitability, protect the environment, and lead to a more sustainable agriculture industry.

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