VARIABILITY IN CWRS WHEAT YIELD RESPONSE TO APPLIED NITROGEN IN MANITOBA SOIL LANDSCAPES

BY

LAURENT (Larry) DAVID JOSEPH DURAND

A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment for the Degree of

MASTER OF SCIENCE

Department of Soil Science
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THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

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ABSTRACT

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Increasing economical and environmental pressures has sparked a great deal of interest in precision agriculture. Thus, a great deal of research has been initiated in order to gain a greater understanding of how existing technologies such as global positioning systems, geographic information systems, and equipment with variable rate capabilities can be used to manage agricultural amendments at a site specific level.

In 1996 and 1997, small plot trials were established at six sites in Southern Manitoba. Four of these sites were located on glacial till landscapes of the Newdale Association and the other two were located on lacustrine landscapes of the Red River Association. A variety of soil and crop parameters were examined throughout the study. Replicated small plots with fertilizer N rates ranging from 0 to 200 kg N ha^{-1} were established in various positions in the landscape based on relative elevation, slope morphology, and slope aspect. The objective of the study was to determine if there were any significant differences in yield response to applied N in Canada Western Red Spring wheat in these landscapes.

In the glacial till landscapes, a number of the soil parameters were found to be strongly associated with landscape position. Among these parameters, electrical conductivity, depth of A horizon, solum depth, NO_3^--N, volumetric water content, and growing season N uptake tended to demonstrate the most consistent differences among landscape positions. However, yield and grain protein responses to applied nitrogen were extremely inconsistent throughout the study in these landscapes.

The soil parameters studied in the lacustrine landscapes demonstrated very different trends than those observed at the glacial till landscapes. Significant differences of the various soil properties studied were seldomly observed among landscape positions at these sites. However, the yield potential and yield response data was much more consistent and predictable.

The use of landscape position as the only variable in determining differences in yield responses to applied N proved to be ineffective in the glacial till landscapes studied. In these landscapes, more comprehensive models with various other soil parameters may need to be developed in order to make variable rate nitrogen decisions. However, the use of landscape positions to make variable rate nitrogen decisions in lacustrine landscapes may be more promising.

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LIST OF ABBREVIATIONS
(in order of appearance in text)

CWRS: Canada Western Red Spring

SCZ: Soil Climatic Zone

CWAD: Canada Western Amber Durum

NUE: Nitrogen Use Efficiency

Δplant N/ΔN fertilizer: change in plant nitrogen content/change in nitrogen fertilizer applied

UNR: Unit Nitrogen Requirement

VRF: Variable Rate Fertilization

CSSC: Canadian System of Soil Classification

GLR.BLC: Gleyed Rego Black Chernozem

O.BLC: Orthic Black Chernozem

CA.BLC: Calcareous Black Chernozem

R.BLC: Rego Black Chernozem

GL.BLC: Gleyed Black Chernozem

GLCU.HR: Gleyed Cumulic Humic Regosol

GL.HV: Gleyed Humic Vertisol

GLC.HV: Gleysolic Humic Vertisol

g ai: grams of active ingredient

vol.: volumetric

prec.: precipitation

E.C.: Electrical Conductivity

1. INTRODUCTION

Recent advances and interest in variable rate fertilizer technology has sparked a great deal of research relating to within-field variability. In a number of instances, variability in soil properties has been reported to be intimately correlated to the soil-landscape (Brubaker et al. 1993, Hanna et al. 1982, Malo et al. 1974, Moore et al. 1993, Moulin et al. 1994, Pan and Hopkins 1991, Pennock and de Jong 1987, Pennock and de Jong 1990, Verity and Anderson 1990). Many of these properties are also known to significantly influence crop yield and quality factors. As such, researchers (Franzen et al. 1997, Beckie et al. 1997) have proposed a focus on landscaped-based approaches to variable rate fertilizer applications. Unfortunately, no single approach that is consistently agronomically and economically viable has yet been found.

Although it is recognized that systematic variability within the soil-landscape exists, there has been limited work done to determine how this variability affects crop response to fertilizer amendments. In most instances, variable rate fertilizer recommendations are made on the assumption that there is variability within the soil-landscape, but responses to applied fertilizer remain constant throughout the landscape.

In 1996 and 1997, a series of small plot trials were established in both the Newdale Glacial Till Plain and the Red River Lacustrine deposits of Southern Manitoba. The crop under investigation was Canada Western Red Spring (CWRS) wheat (*Triticum aestivum*). The objectives of the study were to:

1) Measure various soil properties and determine whether they were associated with landscape position.
2) Compare differences in CWRS wheat yield and grain protein response to applied nitrogen fertilizer among landscape positions.

The premise of this study is that if systematic differences in soil properties among landscape positions exist and these differences result in predictable differences in CWRS wheat yield and protein responses, more informed variable rate N fertilization decisions can be proposed for this crop.