Evaluation of Enhanced Efficiency Nitrogen Fertilizer Products in Western Canada

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Background

- Sustainable crop production needs agro-economic optimization of nitrogen (N) fertilizer application
  - The 4R (Right Source @ Right Rate, Right Time, and Right Place) nutrient stewardship has potentials for optimizing N fertilizer application

- Enhanced Efficiency N Fertilizer (EEF) products are designed to achieve improved crop N use efficiencies and reduced N losses
  - Controlled release/Polymer coated urea
  - Urease inhibitors
  - Nitrification inhibitors

- Information on agronomic benefits and cost/benefit analyses of EEF is critical for fertilizer application decision making
Objective

- Critically evaluate agronomic effectiveness and economic cost/benefits of enhanced efficiency nitrogen fertilizer (EEF) products under Alberta soil, climate, nutrient management and cropping systems

- Database Development
- Crop Yield Response Modelling
- Cost-Benefit and Sensitivity Analyses
- Update Alberta Farm Fertilizer Information and Recommendation Manager (AFFIRM) web versions
Database Development

• Collected grain yield data from researchers across Western Canada
  • Over 10,000 entries
  • EEF products - controlled release urea (ESN), Super U, eNtrench, N-Serve, and different blends of urea and ESN
  • Crops - wheat, barley and canola

• Most robust set of data was for Spring Wheat (Northern Hard Red - NHR)
  • Covers range of fertilizer products, timing and placement across different soils and weather in Alberta

• Significant gaps in data availability
  • More field research, and data sharing collaborations are needed for building a comprehensive database including all major crops and fertilizer product interactions for Alberta
Crop Yield Response Modelling

- Continuous crop yield response curves were built by using a Harmsen-Mitscherlich equation (Harmsen, 2000a,b) for:
  - 3 moisture levels
  - different fertilizer N application timing, placement and products
  - different agricultural soil zones across Alberta

- These curves show estimated grain yields from nitrogen and moisture availabilities
- These yield curves were driven by water and nitrogen use efficiencies calculated from the compiled field data
Crop Yield Response Modelling

- **Available moisture**: spring soil moisture + May-Aug precipitation + irrigation (if any)

- May-Aug precipitation were estimated based on long-term (1961-2018) Alberta precipitation data (source: Alberta Climate Information Service) for each township
  - (a) Optimum moisture: 10% probability
  - (b) Intermediate moisture: 50% probability
  - (c) Low moisture: 90% probability
Crop Yield Response Modelling

• **Available nitrogen**: soil test nitrate-N + N from previous crop residue + Estimated Nitrogen Release (ENR) through mineralization over the growing season + manure N (if any)
Cost-Benefit and Sensitivity Analyses

• Achieving maximum yield may not always be economically profitable

• Cost/benefit and sensitivity analyses
  • “what-if” scenarios of grain yield and fertilizer N rate optimization based on Investment Ratio (IR)

• Investment ratio (IR) = Dollar returns for each additional dollar spent in nitrogen fertilizer
  • For instance, IR=1.5 means an expected return of $1.5 for each $1 additional spent in nitrogen fertilizer

• A producer chooses an IR based on his/her economic goal
  • to derive estimates for economically optimum N rates and grain yields
Crop: Northern Hard Red (NHR) Spring Wheat

Expected crop price: $6.56/bu
IR: 1.5; $1.5 returns on $1 spent
Cost-Benefit and Sensitivity Analyses (example)

Crop: Northern Hard Red (NHR) Spring Wheat

Expected crop price: $6.56/bu

IR: 1.5; $1.5 returns on $1 spent
Alberta Farm Fertilizer Information and Recommendation Manager (AFFIRM)

- Interactive web-based tool designed to assess the grain yield response for various nitrogen fertilizer products, timing and placement (4R nitrogen management)

- AFFIRM-R (https://mezbahu.shinyapps.io/AFFIRM_R_version_yield_response_nitrogen/)
  - includes only the nitrogen fertilizer recommendation
  - companion version of AFFIRM v3.0

- AFFIRM v3.0 is the full version
  - includes recommendations for all of micro- and macro-nutrients
  - can be accessed through secure log in by using MyAlberta Digital ID (MADI)

- AFFIRM requires agronomic, geographic and economic input information

- Crop yield responses in AFFIRM are limited by the data available from research studies
  - Responses will be augmented as more data from research become available
AFFIRM-R: an Example Scenario

Recommended Nitrogen Fertilizer Rates

- Optimum Moisture Level: 90 lb N/ac
- Intermediate Moisture Level: 60 lb N/ac
- Low Moisture Level: 30 lb N/ac

Crop Nitrogen Sources other than N Fertilizer:
- Soil test nitrogen (0-24 inches) (lb N/ac):
  - 1
- Estimated nitrogen release from mineralization over the growing season (lb N/ac):
  - 0
- Residual nitrogen from previous crop residual (lb N/ac):
  - 0
- Crop available nitrogen from applied manure (lb N/ac):
  - 0
- nitrogen from applied manure (lb N/ac):
  - 0

Economics:
- Expected crop price ($/bu):
  - 66
- Fertilizer price ($/tonne):
  - 7.6
- Price of nutrient ($/lb of N):
  - 0.77
- Investment ratio:
  - 12

Crop and Fertilizer Management:
- Crop: Wheat - Northern Hard Red (NHR)
- Irrigation: No
**AFFIRM-R: an Example Scenario**

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**Optimum Moisture Condition:**

Growing Season (May-Aug) Precipitation = 306 mm
AFFIRM-R: an Example Scenario

Legal Land Location
Township: 12
Range: 23
Meridian: W4

Crop Zones and Soil Conditions
Eco-District:
- LETHBRIDGE PLAIN
Eco-Region:
- MOIST MIXED GRASSLAND
Soil Zone:
- DARK BROWN (SOUTHWEST) AND CYPRUS HILL
Soil Organic Matter (0-6 inches) (%):
- 4.8
Soil Texture:
- Medium
Spring Soil Moisture:
- Optimum

Crop and Fertilizer Management
Crop:
- Wheat - Northern Hard Red (NHR)
Irrigation:
- No

Nitrogen fertilizer product:
- ESN
Nitrogen fertilizer application timing:
- Spring
Nitrogen fertilizer application placement:
- Banded

Crop Nitrogen Sources other than N Fertilizer
Soil test nitrogen (0-34 inches) (lb N/acre):
- 1
Estimated nitrogen release from mineralization over the growing season (lb N/acre):
- 69
Residual nitrogen from previous crop residue (lb N/acre):
- 0
Crop available nitrogen from applied manure (lb N/acre):
- 0

Economics
Expected crop price ($/bu):
- 6.5
Fertilizer price ($/tonne):
- 750
Price of nutrient ($/lb of N):
- 0.77
Investment ratio:
- 1.5

Go to my legal land location
AFFIRM v3.0

MyAlberta Digital ID
A secure way to verify who you are online.

Your single, verified online identity. Safe, secure, and backed by the Government of Alberta.

What is MyAlberta Digital ID?

It’s a free account that lets you prove who you are online without paper documents or face-to-face visits. MyAlberta Digital ID gives you seamless access to a growing range of government sites and services, while protecting your information and privacy.
AFFIRM v3.0

Welcome to AFFIRM Alberta Farm-Fertilizer Information and Recommendation Manager

AFFIRM v.3 is a decision support application designed to assist you in customizing your nutrient management plan for your farming operation based on soil nutrient levels, fertilizer and manure sources and management, climatic and soil variables, crop management, and economic factors. Crop nutrient requirements are dependent upon your soil test data, spring soil moisture status, anticipated growing season precipitation, irrigation management and fertilizer and manure sources to determine fertilizer and manure application rates aimed at optimizing crop productivity and economic profitability based on crop prices, fertilizer nutrient costs and your fertilizer budget. AFFIRM will assist you in understanding the factors that influence crop requirements and in determining a fertilizer program that fits within your budget. AFFIRM allows you to compare nutrient management options based on 4R Nutrient Stewardship (Right Nutrient Source @ Right Rate, Right Time and Right Place). AFFIRM is developed from Alberta or western Canada agronomic research and can recommend fertilizer rates for over 160 different cereal, oilseed, forage and specialty crops grown on either dryland or irrigation within Alberta.

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AFFIRM Checklist

In preparation to use AFFIRM, the following is a checklist of information needed:
- Field legal land location or soil zone;
- Previous crop grown (crop yield, residue management, growing season and irrigation moisture);
- Current crop to be grown;
- Irrigation (if applicable);
- Soil sampling technique (time and depths);
- Soil test laboratory used for soil analyses;
- Soil test laboratory results;
- Manure test results or selected book values for each source of manure;
- Manure management (time, rate and placement of manure application; weather conditions);
- Spring soil moisture conditions;
- Fertilizer products, time of application and placement;
- Fertilizer nutrient costs;
- Expected crop price;
- Farm fertilizer budget.

Info: AFFIRM will be back online February 28, 2018 after a major system upgrade.