Effect of Enhanced Efficiency Nitrogen Fertilizers on Agronomic and Environmental Performance in Grain Corn

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Background

- Enhanced-efficiency nitrogen fertilizers (EENFs) have the potential to improve crop yield and nitrogen use efficiency (NUE) while reducing nitrogen (N) loss and environmental damage.
- Previous research has yielded inconsistent results regarding the impact of EENFs on greenhouse gas (GHG) emissions, residual soil nitrate (NO_3^-) content, and grain yield, because the efficacy of EENFs varies depending on the soil type, temperature, humidity, microbial activity, availability of water, and crop species (Timilsena et al., 2015).

Objectives

- To evaluate the effects of different types, rates, and split application timings of EENFs on environmental and agronomic performance in grain corn.

Methodology

- **Randomized complete block design (RCBD)**
- **Variety:** A4939 G2 RIB (2400 CHU) – Pride Seeds
- **EENFs**
  - PurYield™ – polymer-coated slow-release urea
  - SuperU® – double inhibitor
- **Environmental Performance**
  - GHG analysis (Burton et al. 2008)
  - Residual soil NO_3^-
- **Agronomic Performance**
  - Grain yield (15% moisture)
  - Thousand kernel weight (TKW)
  - Test weight (TW)
  - Harvest index (HI)
  - Fertilizer use efficiency
  - Relative chlorophyll content (SPAD meter)
- **Statistical analysis**
  - Analysis of variance – mixed model SAS 9.4
  - Level of significance – $p<0.05$

Preliminary Results

Table 1: Effect of EENFs on Agronomic and Environmental Parameters in Grain Corn

Treatment	Yield (kg ha^{-1})	TKW (g)	TW (kg hL^{-1})	NUE (kg grain kg N^{-1})	Soil NO_3^- (mg L^{-1}) (0-15 cm)	Soil NO_3^- (mg L^{-1}) (15-30 cm)
P value	**	*	ns	ns	**	ns

Table 2: Effects of Uncoated Urea vs. EENFs on Agronomic and Environmental Parameters in Grain Corn

Treatment	Yield (kg ha^{-1})	TKW (g)	TW (kg hL^{-1})	NUE (kg grain kg N^{-1})	Soil NO_3^- (mg L^{-1}) (0-15 cm)	Soil NO_3^- (mg L^{-1}) (15-30 cm)
Urea vs PY	ns	ns	ns	ns	ns	ns
Urea vs SU	ns	ns	ns	ns	*	ns

Table 3: Effects of EENFs Applied Alone vs. Mixed with Urea (1:1) on Agronomic and Environmental Performance in Grain Corn

Treatment	Yield (kg ha^{-1})	TKW (g)	TW (kg hL^{-1})	NUE (kg grain kg N^{-1})	Soil NO_3^- (mg L^{-1}) (0-15 cm)	Soil NO_3^- (mg L^{-1}) (15-30 cm)
PY vs. PY + urea	ns	ns	ns	ns	ns	ns
SU vs. SU + urea	ns	ns	ns	ns	ns	ns

Table 4: Effects of Standard vs. Reduced Application Rates of EENFs on Agronomic and Environmental Performance in Grain Corn

Treatment	Yield (kg ha^{-1})	TKW (g)	TW (kg hL^{-1})	NUE (kg grain kg N^{-1})	Soil NO_3^- (mg L^{-1}) (0-15 cm)	Soil NO_3^- (mg L^{-1}) (15-30 cm)
Reduced vs. standard PY	ns	ns	ns	ns	ns	ns
Reduced vs. standard SU	ns	ns	ns	ns	ns	ns

Table 5: Effects of Single vs. Split Applications of EENFs on Agronomic and Environmental Performance in Grain Corn

Treatment	Yield (kg ha^{-1})	TKW (g)	TW (kg hL^{-1})	NUE (kg grain kg N^{-1})	Soil NO_3^- (mg L^{-1}) (0-15 cm)	Soil NO_3^- (mg L^{-1}) (15-30 cm)
Split vs. single PY	ns	ns	ns	ns	ns	ns
Split vs. single SU	ns	ns	ns	ns	ns	ns

Note: PY, PurYield™; SU, SuperU®; HI, harvest index; TKW, thousand kernel weight; TW, test weight; NUE, nitrogen use efficiency; ns, not significant
*, $0.01 \le p < 0.05$; **, $0.001 \le p < 0.01$; *** $p < 0.001$.

Discussion and Conclusions

- Significant relationship between the use of EENFs and yield, TKW, and soil NO_3^- content at a depth of 0-15cm.
- SuperU® had significantly lower NO_3^- leaching with no yield penalty compared to urea.
  - SuperU® could reduce environmental impact without compromising yield.
- No significant yield or environmental penalty when applying EENFs alone vs. mixing EENFs with urea.
  - Could mix and save costs.
- No significant yield or environmental penalty when comparing standard vs. reduced rates of application of EENFs.
  - Could use reduced rate and save costs.
- No significant yield or environmental penalty when comparing single vs. split applications of EENfs
  - Could do one application and save costs

References

- Burton DL, Zebarth BJ, Gillam KM, MacLeod JA. 2008. Effect of split application of fertilizer nitrogen on N_2O emissions from potatoes. Can J Soil Sci. 88:229–239.
- Timilsena YP, Adhikari R, Casey P, et al (2015) Enhanced efficiency fertilisers: A review of formulation and nutrient release patterns. J Sci Food Agric 95:1131– 1142.

Acknowledgements

Funding support from the Atlantic Grains Council (AGC) under the Sustainable Canadian Agricultural Partnership (SCAP) program is greatly appreciated.

Agriculture and Agri-Food Canada

Atlantic Grains Council