THE IRRIGATOR

Supplement to March 2020

Enhanced Efficiency Fertilizer in Irrigated Crop Production

Gary Kruger, PAg, CCA, Irrigation Agrologist, Outlook
Saskatchewan Ministry of Agriculture
gary.kruger@gov.sk.ca

Agriculture is searching for technologies that will help the industry deliver sound nutrient management to support increased production, higher profitability, improved sustainability and greater levels of environmental protection. In addition to tried and true agronomic practices such as banding nitrogen in spring and matching application timings to just prior to crop uptake, research has shown environmental benefits by using enhanced efficiency nitrogen fertilizer for crop production. We know nitrous oxide emissions are lower when fertilizer is spring applied. We also know irrigated soils have greater levels of nitrous oxide production than dryland production, but the issue is very complex. Research has not been able to sort out these factors in definitive fashion.

ICDC has conducted a series of projects at the research station and on local irrigated production fields evaluating potential yield benefits of enhanced efficiency nitrogen fertilizers. These products have been developed to minimize nitrogen losses from volatilization and denitrification. A 2018 randomized complete block design trial with four replications compared fourteen treatments: combinations of four nitrogen sources – bare urea, Agrotain urea, Super U and ESN and three placement methods – fall banding, fall broadcast, and spring sidebanded. The best performing placement was fall banded N, but the spring sidebanded urea treatment was statistically equal. The best performing products were ESN and Super U, but both of these products come with a premium added cost. Urea coated with a polymer (ESN) floats on water until the membrane becomes leaky from adsorption of moisture so ESN is not suitable for broadcast surface application. This product must be placed into the soil to avoid redistribution by drainage water. Another challenge for ESN is that when the product is placed into dry soil, release of the nitrogen is delayed until the moisture and temperature criteria are satisfied. This delay may hinder crop growth if crop uptake of nitrogen is restricted due to a shortage of nitrogen in the soil. Irrigation normally overcomes this shortcoming for this product.

A 2018 field demonstration project included four nitrogen products: bare urea, Agrotain treated urea, Amidas, and Super U spring broadcast just prior to seeding. The seeding operation and early sprinker irrigation was expected to incorporate the nitrogen products into the soil. The 2019 project was fall applied over a light blanket of snow (November 20) on slightly frozen soil. The yields from these two projects are reported in Table 1. Although Super U yielded best and second best among the treatments in the two years, the crop seemed to benefit from use of both a urease inhibitor and a nitrification inhibitor. The enhanced efficiency nitrogen sources add between 8 to 15 cents per pound of N to the cost of the nitrogen source depending on the product choice. If one pound of N cost 50 cents, this would add 15% to 30% to the cost of N fertilization, a significant impact on crop input costs. Even so, economic analysis with the products used in the ICDC field demonstrations shows that the additional cost can be worth this expense for a best case scenario.

Tai McClellan Maaz, Nitrogen Director with International Plant Nutrition Institute, summarized literature from published studies with urease inhibitors conducted in Alberta, Saskatchewan, Manitoba, Montana, North Dakota and South Dakota (2018). Although the average yield benefit from use of urease inhibitors was 7%, the median yield response of 171 observations taken from 16 published studies was 0%. This observation would not inspire growers to use urease inhibitors.

Farrell and David (2014) concluded that direct emissions of nitrous oxides increase with increasing levels of N fertilizer in a linear relationship. The higher yields on irrigated fields mean that the extra nitrogen needed to increase yield also increases emissions of nitrous oxides. Release of nitrous oxides per unit agricultural production for irrigated production was similar, however, to dryland production. A major reduction in yield scaled emissions was observed for split nitrogen applications without impact on yield.

continued on page 2

ICDC
Irrigation Crop Diversification Corporation
Box 1460, 900 McKenzie Street South
Outlook, SK S0L 2N0

Published by the Irrigation Crop
Diversification Corporation (ICDC) and the
Saskatchewan Ministry of Agriculture.
Available online: www.irrigationsaskatchewan.com

Enhanced Efficiency Fertilizer in Irrigated Crop

continued from page 1

Tenuta and Gao (2018) concluded EEF urea products reduced cumulative N2O emissions for 9 of 12 site-years. This was achieved, however, without a corresponding increase in grain yield to compensate for the additional costs. It appears that EEF do reduce N20 emissions consistently, but the yield impacts to crop production are small.

Tomasiewicz and Lemke (2020) found that delaying N application to irrigated fields through fertigation was able to reach similar yields without large upfront N applications. Although yields were not increased by delaying the N application, yields were also not hurt. Using a smaller quantity of N initially and applying the balance of N through fertigation may be a strategy under irrigation to minimize nitrous oxide emissions and the impact of agriculture on global warming.

Table 1: ICDC Strip Trial Results (2018 and 2019) with enhanced efficiency nitrogen fertilizer

Fertilizer application date	May 14, 2018	Economic Assessment	November 20, 2018	Economic Assessment
Canola sale price $10.70/bu	2018 (bu/ac)	Net Benefit	2019 (bu/ac)	Net Benefit
Bare Urea	64	$606.40	65	$646.90
Agrotain Urea	64	$595.20	65	$636.90
Amidas	68	$629.60	65	$629.40
Agrotain Amidas	Not Applied	--	68	$662.40
Super U	74	$696.60	68	$664.00
Maximum yield increase (%)	15%		6%	
Nitrogen Rate Applied	140 lb N/ac		125 lb N/ac	
Growing Season Precipitation	122 mm		178 mm	
Irrigation Applied	150 mm		177 mm	

Thapa et al. (2016) found that soil and management conditions on effectiveness of EEF is not clear. They conducted meta-analysis in three cereal production systems across the globe: rice, corn and wheat. Their work showed that the effect of EEF's on nitrous oxide emissions and crop yields varied greatly with their modes of actions, soil types, and management conditions. Nitrification inhibitors (Nis), double inhibitors (Dis), and controlled-release fertilizers (CRFs) consistently reduced N20 emissions compared with conventional N fertilizers across soil management conditions. The grand mean of N20 emissions decreased 38, 30, and 19% respectively for the three EEF classes. The DIs more effectively reduced N20 emissions in alkaline soils than did NIs, but the trend reversed in acidic soils. Urease inhibitors also reduced N20 emissions compared with conventional N fertilizers in coarse-textured soils and irrigated systems. Crop yields increased by 7% with the use of nitrification inhibitors.

In summary, the greatest emissions reduction of greenhouse gases associated with application of urea to irrigated soils occurred with spring application of products whose mode of action was nitrification inhibitor or in combination with a urease inhibitor. There was no clear evidence that EENFs would consistently provide an increased yield benefit to cover the additional costs of using them.

continued on page 3

Enhanced Efficiency Fertilizer in Irrigated Crop

continued from page 2

Farrell, R.E. and David, C.L. 2014. Greehouse gas emissions and mitigation in irrigated cropping systems of the northern great plains: A Western Canadian Perspective.

Farrell, R.E., Walley, F. Lemke, R., Tomasiewicz, D. and Ogilvie, C. 2019. Can enhanced efficiency N fertilizers mitigate against N losses in single-pass seeding operations? ADF Final Report 20140257, University of Saskatchewan.

Maaz, T. M. 2018. Enhanced efficiency nitrogen fertilizers: the What, When & Where. Alberta Agronomy Update, Red Deer Sheraton Hotel, Red Deer, AB.

Tenuta, M. and Goa, X. 2018. A matter of timing and source: Enhanced efficiency nitrogen fertilizers and products to reduce nitrous oxide emissions from soils in the prairie provinces. Mimeo report. University of Manitoba

Thapa, R., Chatterjee, A., Awale, R., McGranahan, D.A., and Daigh, A. 2016. Effect of enhanced efficiency fertilizers on nitrous oxide emissions and crop yields: A meta-analysis. SSSAJ 80:1121-1134.

Tomasiewicz, D. and Lemke, R. 2020. Fertigation of Irrigated Canola and Wheat. Irrigated Crop Production Update. January 14, 2020. Sandman Signature Lethbridge Lodge, Lethbridge, AB. Demofarm.ca

Broderick Irrigated Field Demonstrations of Enhanced Efficiency Nitrogen Fertilizers Applied on Canola

Joel Peru[1], Irrigation Agrologist, PAg. CCA, Garry Hnatowich[2], ICDC Research Director, PAg., Scott Anderson[3], Ultimate Yield Advisor, CCA, Rigas Karamanos[4], PAg, Senior Agronomist and Gary Kruger[1], Irrigation Agrologist, PAg., CCA. [1]Saskatchewan Ministry of Agriculture, Outlook, SK, [2]Irrigation Crop Diversification Corporation, Outlook, SK,
[3]The Rack, Broderick, SK and [4]Koch Fertilizer Canada ULC, Calgary, AB Corresponding email: joel.peru@gov.sk.ca

Abstract:

Nitrogen fertilizer field demonstrations were completed in both 2018 and 2019 in the Broderick irrigated area near Outlook, SK with canola. The projects compared performance of different nitrogen sources. The products were broadcast on the soil surface to maximize time efficiency for producers.

Project Objective:

The objective of the projects was to increase canola yield by reducing nitrogen nutrient loss in an irrigated field.

Demonstration Site:

In 2018, the project was located on Dark Brown Tuxford clay loam, a mixture of solonetz and solodized solonetz soils. The site was developed for irrigation in 2004. A second project seeded in 2019 was located on Dark Brown Asquith fine sandy loam soil formed on fluvial parent material. This site was developed for irrigation in 1969 using gravity supplied irrigation water. The field was converted to sprinkler pivot irrigation in 1995.

Project Methods and Observations:

Nitrogen was broadcast on the soil surface in spring 2018 at 140 lb N/ac just prior to seeding. The fertilizer was applied with a 70 ft Case IH Titan 4530 floater on May 14, 2018. The four fertilizers applied in spring 2018 included bare urea, Agrotain treated urea, bare Amidas, and Super U. The site was seeded with a Bourgault air seeder. Phosphorus was applied side banded at 50 lb P205/ac. The site was harvested Sept. 28, 2018. For the 2019 project, the nitrogen fertilizer was broadcast on the soil surface in fall on November 20, 2018 with the same 70 ft Case IH Titan 4530 floater. The treatment list in 2019 included an additional treatment - Agrotain treated Amidas. The 2019 project received 125 lb N/ac. The N was applied broadcast on the soil surface. There was a skiff of snow present, and the soil was slightly frozen. The project was seeded May 18 with an air drill. Phosphorus was applied side banded at 50 lb P205/ac.

Table 1: Broadcast Fertilizer Application

2018		2019	
Nitrogen Source	Rate of Product @ 140 lb N/ac	Nitrogen Source	Rate of Product @ 125 lb N/ac
Bare Urea	304	Bare Urea	272
Agrotain treated Urea	304	Agrotain treated Urea	272
Amidas	350	Amidas	313
Super U	304	Agrotain treated Amidas	313
		Super U	272

Figure 1: Canola yield (bu/ac) using enhanced efficiency fertilizer applied broadcast to cereal stubble in spring. N Rate = 140 N/ac

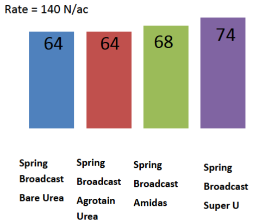
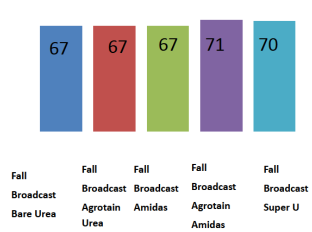


Figure 2: Canola yield (bu/ac) using enhanced efficiency fertilizer applied broadcast to cereal stubble in fall. N Rate = 125 lb N/ac



Results:

The demonstrations showed that the more costly environmentally friendly fertilizer treatments have potential to yield superior financial returns as well as benefits for the environment. Maaz (2018) found that the yield increase with use of urease inhibitors in the North American Great Plains was positive on average (7%), but the median of these observations was only 0%.

Table 2 Economic Analysis of ICDC Fertilizer Demonstration

2018 Demonstration : Fertilizer Broadcast May 14, 2018 Seeded May 15, 2018				
	cents/lb N	Yield	140 N/ac	Net Revenue
Spring Urea	50	64	$70.00	$615.08
Spring Agrotain Urea	58	64	$81.20	$603.88
Spring Super U	65	74	$88.20	$703.60
Spring Amidas	59	68	$82.60	$645.00
	Harvested September 28, 2018			
2019 Demonstration: Fertilizer broadcast November 20, 2018				
	cents/lb N	Yield	125 N/ac	Net Revenue
Fall Urea	49	67	$61.25	$655.65
Fall Agrotain Urea	57	67	$71.25	$645.65
Fall Super U	64	70	$80.00	$669.00
Fall Amidas	59	67	$73.75	$643.15
Fall Agrotain Amidas	67	71	$83.75	$675.95
Seeded May 18, 2019 Harvested October 13, 2019				

Conclusion:

Enhanced efficiency nitrogen fertilizer does increase costs, but net revenue with some of the products was still better than less costly alternatives under irrigated conditions. The best performing fertilizer products were spring Super U in 2018 and fall Agrotain Amidas in 2019. Under some conditions, nitrogen products which reduce nitrous oxide emissions can still provide more economical agronomic production than the less costly nitrogen alternatives.

Acknowledgements:

The Rack's Scott Anderson, Kent Clark and their staff assisted with the projects in both years. The project was funded by Koch Industries in 2018 and by ADOPT through the Canadian Agricultural Partnership in 2019. Koch Industries provided research product both years. The assistance of The Rack is also gratefully acknowledged.

Disclaimer: Fertilizer prices fluctuate with market conditions. The economic analysis is for illustrative purposes only.

References:

Maaz, T. M. 2018. Enhanced efficiency nitrogen fertilizers: the What, When & Where. Alberta Agronomy Update, Red Deer Sheraton Hotel, Red Deer, AB.

Thapa, R., Chatterjee, A., Awale, R., McGranahan, D.A., and Daigh, A. 2016. Effect of enhanced efficiency fertilizers on nitrous oxide emissions and crop yields: A meta-analysis. SSSAJ 80:1121-1134.

Saskatchewan

ICDC Irrigation Crop Diversification Corporation

KOCH AGRONOMIC SERVICES

CANADIAN AGRICULTURAL PARTNERSHIP