Growing Potatoes with Slow-release Nitrogen Fertilizer

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Nitrogen management practices have an effect on crop yields but they can also have a negative impact on the environment. Practices such as banding fertilizer and/or split-applying total nitrogen needs per acre offer a more efficient use of nitrogen by significantly reducing nitrate leaching potential. Heavy rains occurring when plants are small and nitrogen demands are low can also increase nitrate contamination of ground and surface waters. For instance, split-applying nitrogen minimizes the amount of nitrogen in the soil profile early, when plant N demands are low and there is a greater potential for leaching from rain events. Recently, fertilizer companies have added another tool growers can use to increase plant nitrogen use efficiency and decrease nitrate leaching potential. Slow-release, or controlled-release, nitrogen fertilizers have been commercially available for many years in the Floriculture industry with products such as Osmocote but recent advances have made this technology economically feasible and available for use in row-crop production. Controlled-release nitrogen fertilizers that we evaluated are made up of a urea (44-0-0) core which is surrounded by a polymer coating. The polymer coating allows water to enter, liquefying the urea core. Then, through temperature controlled diffusion, the liquid urea is metered out of the polymer coating over the course of 90 days or so into the soil profile. Coating thickness can be adjusted to increase or decrease days to 90% nitrogen release. As temperatures increase, so does nitrogen release rate and plant nitrogen demands thus increasing nitrogen use efficiency.

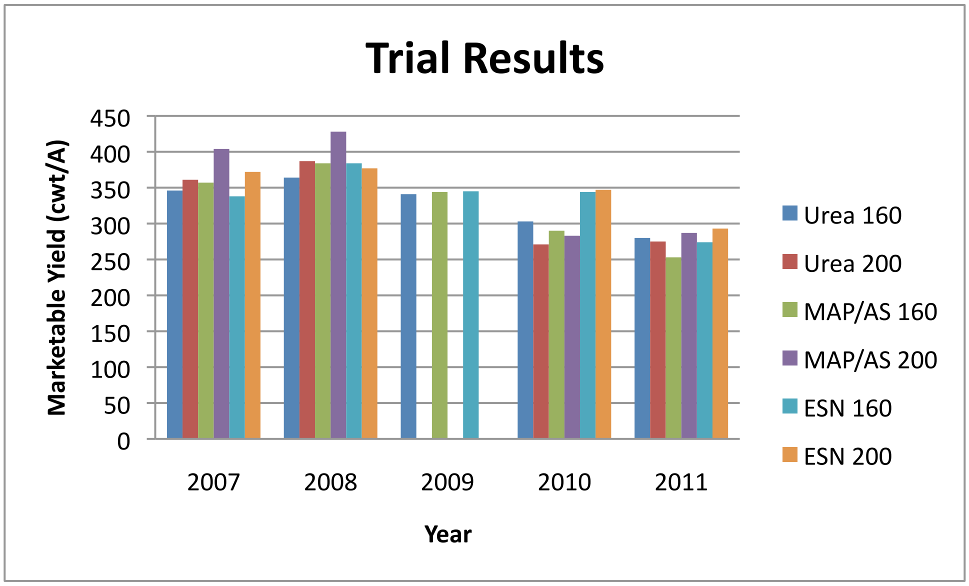
Controlled-release nitrogen fertilizers were evaluated against conventional nitrogen fertilizer sources over the past several years as a means of increasing nitrogen use efficiency and decreasing environmental impacts of nitrogen in potato production systems. This year, leachate samples were collected to quantify nitrate leaching from the different fertilizer programs. The trials were established in a Haven loam soil in Riverhead, NY. The controlled release nitrogen fertilizer source used was ESN® (44-0-0), a polymer coated urea from Agrium Advanced Technologies which was then blended with conventional nitrogen fertilizer sources to achieve two controlled release nitrogen fertilizer blends: ESN® 60:40 and ESN® 80:20. The 60:40 blend contained 60% of the total N in the form of controlled release N or ESN® and the remaining 40% of the total N as conventional N from monoammonium phosphate (MAP) (11-52-0) and ammonium sulfate (AS) (21-0-0). The 80:20 nitrogen blend contained 80% of the total N as ESN® and the remaining 20% as MAP. The two conventional nitrogen fertilizer programs included a urea (46-0-0) treatment with a urea sidedress component and a MAP/AS treatment with an ammonium nitrate (34-0-0) sidedress component. A no fertilizer control program was added as a benchmark comparison. Fertilizer programs were evaluated at two N rates, 160 and 200 lbs per acre. At planting, the conventional fertilizer treatment plots received 100 lbs N/A while the controlled release nitrogen fertilizer treatment plots received either 160 lbs or 200 lbs N/A depending on the treatment. Also, at planting all treatments received 200 lbs/A phosphorus from both MAP and triple super phosphate (0-45-0), 200 lbs/A potassium from both muriate of potash (0-0-60) and K-Mag (0-0-22), plus 33 lbs/A magnesium from K-Mag. On June 6, conventional fertilizer treatment plots were sidedressed with 60 or 100 lbs N/A, either as urea or ammonium nitrate, depending on treatment.

‘Reba’ potatoes, a mid-season round white variety were planted each year. In 2011, immediately after planting, one 4-foot long ceramic suction cup lysimeter was installed in each plot into a non-harvest row by drilling a hole 3.5 feet deep and then backfilling the soil around the lysimeter. Leachate samples were collected every two weeks, frozen, and then sent to Brookside Laboratories Inc. (Ohio) for nitrate-N analysis.

Results from the trials over the years have been fairly consistent. Each year it is apparent the influence weather, especially early-season rainfall, has on the results and possible benefits that can be obtained. For example, in growing seasons where there is very little rainfall before June, yields between the controlled release nitrogen fertilizer programs (CRNF) and the conventional nitrogen fertilizer programs are similar. In some seasons, the trend may be more toward a nitrogen rate effect, such as 200 lbs N/A yielded greater than 160 lbs N/A regardless of N fertilizer source, but the bottom line is there is no yield difference obtained between the two fertilizer sources. On the other hand, when leaching rain events occur in April or May, there is a trend toward increasing yields with CRNF over conventional fertilizer sources applied at the same N rate and even the potential to reduce N rates by 20% with CRNF and yield similar to the conventional fertilizer programs at the full rate. However, due to the unpredictability of weather it is recommended that growers first experiment with CRNF at standard N rates and then as you feel more comfortable with the products, reduce the amount of N per acre by no more than 20% of your standard practice as long as N rates/A do not drop below University recommendations.

Although more expensive, in our trials we had greater marketable yields obtained when the CRNF blend contained 80% of the total nitrogen as controlled release and the remaining 20% as conventional nitrogen compared to CRNF blends containing 60% of the total N as controlled release. Usually, the increased costs are compensated for with greater yields. Also, it is assumed the environmental impact will also be reduced the greater the percentage of controlled release nitrogen used *(Note: using 100% controlled release nitrogen was unsuccessful in our trials and therefore discontinued evaluating it early on)*. Lysimeters were installed in 2011and nitrate levels in the leachate collected were determined to help evaluate the environmental impact of controlled release nitrogen fertilizers.

Nitrate levels in leachate collected from the various fertilizer programs did not significantly differ over the course of the season. However, nitrate levels were slightly higher in leachate from the CRNF 80:20 programs compared to the CRNF 60:40 programs, independent of N rate, indicating that there may be more late season N release from the 80:20 blends or too much nitrogen in the controlled release form causing too much release to occur after the potato plant could efficiently take it up. In 2011, it can be reasoned that conventional nitrogen fertilizer programs where the total N rate per acre is split between 2 applications is comparable as a management practice in regard to reducing nitrate leaching levels in groundwater to CRNF programs where the total N rate per acre is applied all at planting. However, further research is needed to confidently identify the environmental impacts of CRNF and which blends would result in less leaching potential.


Trial Results
Marketable Yield (cwt/A)
450
400
350
300
250
200
150
100
50
0
2007
2008
2009
2010
2011
Year
Urea 160
Urea 200
MAP/AS 160
MAP/AS 200
ESN 160
ESN 200

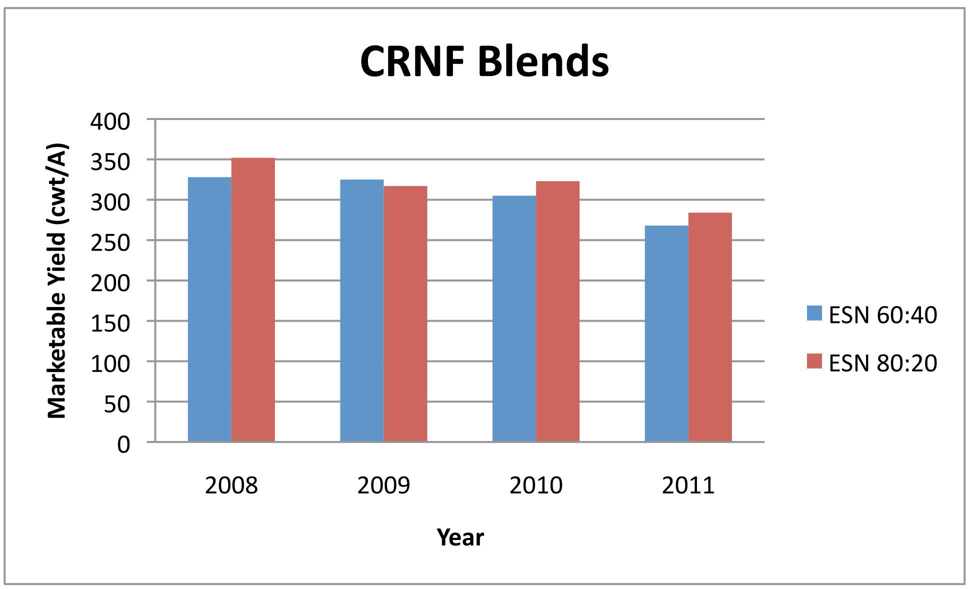

CRNF Blends
Marketable Yield (cwt/A)
400
350
300
250
200
150
100
50
0
2008
2009
2010
2011
Year
ESN 60:40
ESN 80:20

Table 15. Effects of different nitrogen fertilizer treatments on the Nitrate-N levels in soil water samples collected from lysimeters installed in a field of 'Reba' potatoes grown in Riverhead, NY, 2011.

	At Planting[2]	At Sidedress[3]	Total	Nitrate-N Levels (ppm)										Season
N Fertilizer Source[1]	(lbs N/A)	(lbs N/A)	(lbs N/A)	5/9	5/23	6/13	6/27	7/11	7/27	8/8	8/18	9/1	9/22	Mean
Control	0	0	0	3.8	4.4	5.5	5.9	6.3	6.0	4.6	5.1	6.9	8.8	5.7
Urea	100	60	160	4.0	5.5	6.8	7.6	8.5	8.8	8.3	21.2	22.1	19.3	11.2
Urea	100	100	200	3.9	4.8	6.4	7.7	7.1	8.8	7.0	14.1	16.2	23.3	9.9
MAP/AS	100	60	160	4.2	4.8	7.9	7.5	8.0	7.2	8.4	10.7	17.1	17.3	9.3
MAP/AS	100	100	200	4.9	6.6	9.0	9.2	9.7	9.5	8.8	11.7	14.6	14.1	9.8
ESN® Blend 60:40	160	0	160	4.0	7.8	6.4	6.9	7.7	8.7	8.0	9.6	13.1	11.3	8.3
ESN® Blend 60:40	200	0	200	5.4	5.4	7.2	8.0	8.7	8.6	7.8	13.0	23.8	25.5	11.3
ESN® Blend 80:20	160	0	160	5.3	6.0	15.9	17.7	18.7	14.1	10.5	11.4	13.2	11.8	12.4
ESN® Blend 80:20	200	0	200	4.1	7.3	6.9	7.0	7.5	8.5	7.2	21.3	28.3	22.0	12.0
Fisher's Protected LSD (0.05)				*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(9.9)*	*(ns)*
Main Effects:														
N source and application														
Control, no fertilizer				3.8	4.4	5.5	5.9	6.3	6.0	4.6	5.1	6.9	8.8	8.0
Urea, split application				4.0	5.1	6.6	7.7	7.8	8.8	7.6	17.7	19.1	21.3	13.8
MAP/AS, split application				4.6	5.7	8.4	8.4	8.9	8.3	8.6	11.2	15.8	15.7	13.0
ESN® 60:40 Blend, at planting				4.7	6.6	6.8	7.4	8.2	8.6	7.9	11.3	18.7	18.4	13.1
ESN® 80:20 Blend, at planting				4.7	6.7	11.4	12.3	13.1	11.3	8.8	16.3	20.8	16.9	16.8
				(ns)	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*
Total N Rate (lbs/A)														
0				3.8	4.4	5.5	5.9	6.3	6.0	4.6	5.1	6.9	8.8	8.0
160				4.4	6.0	9.2	9.9	10.7	9.7	8.8	13.2	16.5	14.9	14.3
200				4.6	6.0	7.4	8.0	8.3	8.8	7.7	15.0	20.7	21.2	14.1
				(ns)	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(ns)*	*(5)*	*(ns)*
Statistical Analysis (0.05)				p-value	p-value	p-value	p-value	p-value	p-value	p-value	p-value	p-value	p-value	p-value
N Source				0.6873	0.6422	0.3321	0.5431	0.4515	0.6023	0.8763	0.3848	0.8522	0.4313	0.4423
N Rate				0.6541	0.9756	0.3700	0.4749	0.3475	0.6287	0.3610	0.5827	0.3045	0.0175	0.9166
N Source x N Rate				0.5405	0.6978	0.3140	0.5520	0.4077	0.6181	0.7172	0.3223	0.3260	0.0188	

[1]Control = no fertilizer. Urea (46-0-0); MAP = Monoammonium Phosphate (11-52-0) and AS = Ammonium Sulfate (21-0-0). ESN® Blend 60:40 = 60% of the total N as ESN® (44-0-0) or controlled release N and the remaining 40% as MAP and AS. ESN® Blend 80:20 = 80% of the total N as ESN® and the remaining 20% as MAP.

[2]All treatments received 200 lbs/A phosphorus either from MAP and/or Triple Super Phosphate (0-45-0), 134 lbs/A potassium from murate of potash (0-0-60), and an additional 66 lbs/A potassium and 33 lbs/A magnesium from K-Mag at planting.

[3]Sidedress treatments were applied on June 6 when plants were 4-8" tall. At sidedress, urea treatments were fertilized with urea (46-0-0) and MAP/AS treatments were fertilized with ammonium nitrate (34-0-0).