

## **Delayed-release Nitrogen Fertilizer Effects on Sugar Beet Yield and Quality**

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Nitrogen management remains a crucial component in sugarbeet products systems. Appropriate rate and timing of N fertilizer applications are critical to profitable sugarbeet production. Adequate N is required during early growth stages for promotion of canopy development to optimize light interception. Rapid early growth is crucial for attaining maximum yield and quality. However, high levels of mid to late season soil N results in luxury consumption, deteriorating final sugarbeet quality. These limitations require N applications be made early in the season, with all N either at or immediately preceding planting, or some N at planting followed by a split application when sugarbeets are still small.

In an effort to minimize early season N losses and better match in-season sugarbeet N demand, delayed-release N fertilizers have been introduced as possible N sources. These products hold potential to not only better match sugarbeet N demand than conventional mineral N sources, but also mitigate risk of N loss prior to crop uptake. Delayed-release N products differ in their compositions, release mechanisms, and handling characteristics. Of these, polymer-coated urea (PC) and liquid polymer formaldehyde N (LP) have become the most established for agricultural applications. These products release available N during the growing season at a rate influenced by incorporation, soil moisture, and soil temperature. New to sugarbeet systems, the release of these products will not only have to meet early season N requirements, but also avoid excess late season N release that will decrease sugarbeet quality.

This study was established in 2007 and repeated in 2008, evaluating two delayed-release N products, ESN, a polymer coated urea manufactured by Agrium, and a liquid polymer N product from Georgia Pacific. Sites were located in Saginaw county at the Bean and Beet Research Farm, and in Tuscola county, near Quanicassee. Conventional mineral N and delayed-release N fertilizers were applied separately and in combination at several proportions at two N rates, 80 and 110 lb N ac<sup>-1</sup> (Table 1). A control treatment, receiving no N, was compared to seven source combinations. Nitrogen was applied as either pre-plant broadcast incorporated, starter applications at planting, or sidedressed at the four leaf stage. Plots were arranged in a randomized complete block design with four replications, measuring 6 rows wide by 40 feet long. Corn preceded sugarbeets at all locations.

Soil samples were obtained from control treatments for site characterization prior to fertilization at 0-6 and 6-12 inch depths. Beginning several weeks after fertilization and continuing until August, soil samples were taken on 10-14 day intervals from each plot at a 0-6 inch depth for evaluation of soil N status. Following harvest, soil samples were taken from each from each plot at 0-6, 0-12, and 12-24 inch depths for soil N analysis.

Sugar beets were harvested for determination of root yield and subsamples were analyzed for quality components including recoverable sucrose, clear juice purity (CJP), and amino N. These quality components were used to calculate recoverable white sucrose per ton (RWST) and recoverable white sucrose per acre (RWSA). Site and year effects were significant for all yield parameters, so sites and years were not combined for analysis.

Consistent differences in sugarbeet tonnage were not observed between sites or years (Table 2). Control treatments always resulted in decreased tonnage compared to any N treatment. Few treatment effects were observed at 2007 Saginaw or 2008 Tuscola. At these locations, 80 lb N ac<sup>-1</sup> treatments with all N applied as a single source pre-plant (100% UR and 100% PC treatments) tended to have lower yield than any 110 lb N ac<sup>-1</sup> N source combination treatments. At 2007 Tuscola and 2008 Saginaw, more variability between treatments was observed, and no discernable trends could be identified.

Few treatment differences were observed for RWST (Table 3). High proportions of PC in 110 lb N ac<sup>-1</sup> treatments in 2007 at both Saginaw and Tuscola tended decreased RWST compared to other treatments with lower proportions of delayed release N products or conventional mineral fertilizer alone. No trends in RWST could be indentified at either Saginaw or Tuscola in 2008.

Recoverable white sucrose per acre, and function of both tonnage quantity and RWST quality, tends to be a compromise between treatment effects observed with these other parameters. Nitrogen rates did not influence response to delayed-release or conventional mineral N products (Table 4). Few trends could be indentified between or within sites. Control treatments with no N always resulted in decreased RWSA. Generally, 30% LP treatments, regardless of N rate, tended to have numerically decreased RWSA. Treatments with all urea (100% UR) or PC (100% PC) at low 80 lb N ac<sup>-1</sup> rates were often observed to have numerically lower RWSA compared to other N treatments.

Delayed release N products did not have consistent effects on sugarbeet tonnage, RWST, or RWSA. Moderate to low proportions of delayed-release N products and split conventional N applications were generally observed to have the highest RWSA. Of note, however, is that weather conditions were not particularly conducive to early season N losses. No site received heavy early season rains that could have induced leaching or denitrification losses. Delayed-release products are designed to particularly reduce N losses in these situations, and may result in different results in more loss prone weather conditions. Delayed-release sources were also not observed to deteriorate sugarbeet processing quality, an initial concern with the use of these products. While no significant yield benefits were found with the use of delayed-release N products, results of this research does not indicate consistent detrimental effects associated with their use in N management programs.

Table 1. Delayed release and conventional mineral fertilizer treatment proportions. All treatments applied at 80 and 110 lb N ac<sup>-1</sup>

Preplant	2x2 Starter	Sidedress
--	--	--
100% UR	--	--
	50% UR	50% UAN
15% LP / 35% UAN	50% UR	--
33% LP / 67% UAN	--	--
33% PC / 67% UR	--	--
50% PC	50% UR	--
100% PC	--	--

*UR*- urea

*UAN*- urea ammonia nitrate solution

*PC*- poly-coated urea

*LP*- liquid-polymer N

Table 2. Sugarbeet yield response to delayed-release and conventional mineral N fertilizer treatments ( $\alpha=0.05$ )

		2007		2008					
		Saginaw	Tuscola	Saginaw	Tuscola				
		----- ton/ac -----							
	Control	24.8	c	27.0	e	13.9	e	28.6	c
80 lb N ac <sup>-1</sup>	100% UR	30.6	ab	31.5	d	24.5	bcd	35.6	b
	50% UR / 50% UAN	32.7	ab	33.5	bcd	24.8	bcd	38.5	ab
	15% LP / 35% UAN / 50% UR	33.0	ab	36.0	abc	22.8	cd	37.4	ab
	30% LP / 70% UAN	30.6	ab	33.5	bcd	21.1	d	35.3	b
	30% PC / 70% UR	31.4	ab	34.4	abcd	24.5	bcd	36.1	ab
	50% PC / 50% UR	31.4	ab	32.9	dc	26.8	abc	37.1	ab
	100% PC	30.1	b	35.0	abcd	24.4	bcd	35.6	b
110 lb N ac <sup>-1</sup>	100% UR	32.8	ab	37.4	ab	28.0	ab	39.0	ab
	50% UR / 50% UAN	33.3	ab	35.9	abc	26.2	abc	40.2	a
	15% LP / 35% UAN / 50% UR	34.3	a	38.0	a	26.4	abc	37.6	ab
	30% LP / 70% UAN	33.9	ab	32.8	dc	24.1	bcd	36.2	ab
	30% PC / 70% UR	32.7	ab	35.4	abcd	27.4	abc	36.5	ab
	50% PC / 50% UR	31.7	ab	35.9	abc	25.1	bcd	39.1	ab
	100% PC	32.7	ab	37.6	a	30.0	a	37.5	ab

Table 3. Sugarbeet RWST response to delayed-release and conventional mineral N fertilizer treatments ( $\alpha=0.05$ )

		2007		2008					
		Saginaw	Tuscola	Saginaw	Tuscola				
		----- RWST -----							
80 lb N ac <sup>-1</sup>	Control	262	abcd	265	ab	277	ab	309	a
	100% UR	266	ab	264	ab	281	ab	298	b
	50% UR / 50% UAN	258	cdef	266	a	285	a	297	b
	15% LP / 35% UAN / 50% UR	263	abcd	266	a	283	ab	300	ab
	30% PC / 70% UR	260	abcde	258	abc	284	a	295	b
	30% LP / 70% UAN	251	ef	256	abc	282	ab	301	ab
	50% PC / 50% UR	267	a	263	ab	279	ab	300	b
	100% PC	254	def	261	abc	281	ab	296	b
110 lb N ac <sup>-1</sup>	100% UR	255	cdef	255	bc	273	b	297	b
	50% UR / 50% UAN	258	abcdef	262	abc	285	a	296	b
	15% LP / 35% UAN / 50% UR	263	abcd	254	bc	280	ab	295	b
	30% PC / 70% UR	264	abc	259	abc	283	ab	299	b
	30% LP / 70% UAN	260	abcde	260	abc	276	ab	293	b
	50% PC / 50% UR	250	f	251	cd	282	ab	295	b
	100% PC	251	ef	243	d	280	ab	292	b

Table 4. Sugarbeet RWSA response to delayed-release and conventional mineral N fertilizer treatments ( $\alpha=0.05$ )

		2007		2008					
		Saginaw	Tuscola	Saginaw	Tuscola				
		----- RWSA -----							
80 lb N ac <sup>-1</sup>	Control	6482	d	7141	e	3851	d	8852	c
	100% UR	8133	abc	8323	d	6881	abc	10616	b
	50% UR / 50% UAN	8397	abc	8931	abcd	7063	abc	11415	ab
	15% LP / 35% UAN / 50% UR	8689	abc	9579	ab	6438	bc	11210	ab
	30% LP / 70% UAN	7670	c	8576	cd	5968	bc	10590	b
	30% PC / 70% UR	8167	abc	8893	abcd	8373	a	10627	b
	50% PC / 50% UR	8388	abc	8637	bcd	7479	abc	11104	ab
	100% PC	7659	c	9128	abcd	6859	abc	10538	b
110 lb N ac <sup>-1</sup>	100% UR	8363	abc	9536	abc	7661	abc	11577	ab
	50% UR / 50% UAN	8601	abc	9385	abc	7459	abc	11910	a
	15% LP / 35% UAN / 50% UR	9028	a	9652	a	7403	abc	11081	ab
	30% LP / 70% UAN	8825	ab	8535	cd	6632	bc	10597	b
	30% PC / 70% UR	8612	abc	9181	abcd	7767	ab	10907	ab
	50% PC / 50% UR	7953	bc	9016	abcd	7074	abc	11523	ab
	100% PC	8217	abc	9147	abcd	8406	a	10937	ab