2015 High Density Vegetable Nitrogen Evaluations

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Summary: Nitrogen fertilizer technologies are commonly used in the Corn Belt to improve nitrogen use efficiency of applied fertilizer and to reduce nitrogen losses via volatilization of urea and ammonical fertilizers, as well as nitrate leaching. Two general classes of materials exist, nitrification inhibitors and controlled release fertilizers. Nitrification inhibitors disrupt the activity of the bacteria (*Nitrosomonas sp.* and *Nitrobacter sp*.) that convert ammonium to nitrate, thereby maintaining a higher percentage of the nitrogen as positively charge ammonium which is less susceptible to leaching. Controlled release forms of nitrogen slowly release nitrate from plastic coated prills of urea or are forms of urea that slowly break down in the soil. We have evaluated these materials for several years to see if they might have a fit in cool season vegetable production. Nitrogen technology materials were tested in three of the four trials reported here. Materials tested included: NovaTec (ammonium sulfate treated with dimethlpyrazolphosphate (DMPP)), ammonium sulfate treated with nitrapyrin, Duration ST (polyurethane coated prills of urea), and SuperU (urea prills impregnated with dicyandiamide (DCD) and a urease inhibitor). Three evaluations of nitrogen technologies were conducted, two on spinach and one on mizuna. The nitrogen technologies did not perform well in the spinach evaluations this year. We did not see an improvement in yield with any of the nitrogen technologies in either trial. It is not clear why the results for the two spinach trials were not as positive as in the past. In the mizuna trial we obtained the same yield with NovaTec and Duration ST at 120 lbs N/A as the grower standard that used 180 lbs N/A.

In a trial where we compared managing a spinach crop using the recommendations from CropManage and grower standard practices. Based on residual soil nitrate levels we applied 116 lbs N/A on the CropManage treatment and 180 lbs N/A on the standard treatment. There was not difference in yield between the two treatments 24 days after first germination water date, but there we measured 5% lower yield in the CropManage treatment in a commercial harvest 32 days after first germination water. Soil nitrate levels were lower in the CropManage treatment at harvest and that may have accounted for the lower yield.

Methods: ***Trial No. 1:*** This spinach trial was conducted in a commercial production field with a cooperating grower near Gonzales. The soil at the site was Mocho silty clay loam. This was the first crop of the season on this block. Each plot was three 80-inch beds wide by the length of the field. Duration ST and NovaTec were applied at the equivalent of 120 lbs N/A applied prior to planting. The materials were applied by a commercial application rig on April 14. The material was power mulched into the beds on the same day and planted April 22 (Irrigated on April 23). The grower standard had a total of 180 lbs N/A applied (60 lbs N/A at planting and two 60 lbs N/A fertigations on May 6 and 14, respectively). Soil ammonium and nitrate were evaluated by collecting 10 soil cores from each plot down to 12". Initial soil levels at the start of trial (April 14) were 40.1 ppm nitrate. Yield evaluations were conducted on May 22 (29 days after wet date DAWD). ***Trial No. 2:*** This spinach trial was conducted in a commercial production field with a cooperating grower near Castroville. The soil at the site was Pacheco clay. This was the first crop of the season on this block. Each plot was one 80-inch bed wide by 15 feet long with four replications and laid out in a randomized complete block design. All fertilizer treatments were applied at planting (including the grower standard) except for the ammonium sulfate followed by a topdress of 70 lbs N/A on May 17. All preplant treatments were applied on April 17 and

mulched into the soil with a power mulcher. The wet date was April 20. Soil ammonium and nitrate were evaluated by collecting 10 soil cores from each plot down to 12". Initial soil levels at the start of trial (April 14) were 50.9 ppm nitrate. Yield evaluation was conducted on May 27 (37 DAWD). ***Trial No. 3:*** This mizuna trial was conducted on a commercial production field near Gonzales. The soil at the site was Mocho silt loam. Each plot was three 80-inch beds wide by the length of the field. Duration and NovaTec were applied at 120 lbs N/A with a commercial application rig on September 23. The material was mulched into the beds on the same day and planted; first water was on September 25. The grower standard had a total of 180 lbs N/A applied (60 lbs N/A at planting followed by 60 lbs N/A fertigations on October 2 and October 13). Soil ammonium and nitrate were evaluated by collecting 10 soil cores from each plot down to 12". Initial soil level at the start of trial (April 14) was 31.0 ppm nitrate. Yield evaluation was conducted on October 19 (24 DAWD). ***Trial No. 4:*** This spinach trial was conducted on a commercial production field near Gonzales. The soil at the site was Mocho silt loam. This was a large-scale field trial. Each treatment area was 24 80-inch beds wide by the length of the field. Treatments were an area in which irrigation and nitrogen were managed by using the recommendations from CropManage (web based on-line support tool: https://cropmanage.ucanr.edu/) and compared with the standard grower practice. The trial was planted to the variety '1215' on September 23. First water was on September 26. Soil ammonium and nitrate were evaluated by collecting 10 soil cores from each plot down to 12". Initial soil level at the start of trial (September 23) was 36.8 ppm nitrate. The biomass evaluation on October 20 (24 DAFW) was conducted by harvesting 6 1-m^2 plots from each treatment. The October 28 (32 DAFW) evaluation was conducted with the commercial harvester (Photo 1) on three beds in each treatment area by the length of the field. The spinach was harvested into bins which were weighed as they came into the processing plant.

Results: ***Trial No. 1:*** The background levels of residual soil nitrate-N at the trial site were 40.1 ppm at the beginning of the trial. In spite of high residual soil nitrate, all treatments had higher yield than the untreated control (Table 1). The grower standard treatment had higher yield than NovaTec and Duration ST in this trial. However, it was necessary to turn the sprinklers off of the area where the NovaTec and Duration ST treatments were during fertigations of the grower standard treatment (this occurred twice) and this may partially account for the lower yield in these treatments. NovaTec had higher levels of ammonium in the soil than all other treatments over the course of the crop cycle. ***Trial No. 2:*** The residual soil nitrate in the soil at the beginning of the trial was 50.9 ppm nitrate-N. In spite of this high amount of residual soil nitrate, all treatments had significantly greater yield than the untreated control (Table 2). There was basically no yield response between the moderate amount of nitrogen (ammonium sulfate 90 lbs N/A) and the grower standard and the ammonium sulfate with 70 lbs topdressed. Some of the nitrogen technology treatments such as ammonium sulfate treated with nitrapyrin, NovaTec and Duration ST that had lower yields than the moderate nitrogen treatment. It is unclear why this occurred in this trial. Ammonium sulfate treated with nitrapyrin and NovaTec maintained higher ammonium levels than the other treatments except for the ammonium sulfate treatment that was topdressed on May 17. ***Trial No. 3:*** The residual soil nitrate-N levels at the beginning of this trial were 31.0 ppm. NovaTec and Duration ST treatments were applied at 33% less than the grower standard, but there was no statistical difference in the yield among these treatments. ***Trial No. 4:*** This trial was conducted to evaluate using the web based decision support program, CropManage to make decisions on irrigation and nitrogen fertilizer application. In the CropManage treatment, based on soil nitrate levels of 28.9 ppm nitrate (106 lbs N/A), no CAN 17 was applied on October 5, but was applied to the grower standard treatment. This evaluation indicated that the

two treatments yielded similarly. The commercial harvest on October 28 was conducted by harvesting 4 beds from each treatment and weighing the truck loads at the Taylor Farms facility. The data indicate that CropManage treatment yield was 5% lower than the grower standard.

Photo 1. Commercial harvest of trial 4.

Table 1. Trial No. 1. Yield evaluation nitrogen uptake on May 22 and soil mineral nitrogen evaluations over the crop cycle on four dates.

Treatment	Total N lbs/A	Fresh lbs/A	Fresh tons/A	Dry lbs/A	%N	lbs N/A	Soil ammonium-N ppm				Soil nitrate-N ppm			
							Apr 30	May 6	May 13	May 18	Apr 30	May 6	May 13	May 18
NovaTec	120	16,574.7	8.3	1,399.6	5.8	81.2	80.6	9.6	40.2	22.1	31.2	35.8	37.3	22.9
Duration ST	120	16,151.4	8.1	1,433.0	5.5	78.3	4.0	4.2	1.3	1.6	30.8	39.8	36.0	21.6
Grower's Standard	180	20,979.0	10.5	1,644.6	5.8	95.7	na	na	0.5	2.1	na	na	30.2	24.0
Untreated	0	13,411.2	6.7	1,306.1	4.9	63.5	0.6	0.4	0.4	0.7	27.5	31.5	25.4	12.9
Pr>F treat		0.0007	0.0007	0.0027	0.0019	0.0022	0.0023	0.0403	0.0056	0.0163	0.5006	0.0025	0.0153	0.0175
LSD $_{0.05}$		2,072	1.03	122.0	0.36	10.89	28.04	6.38	17.95	12.80	NS	2.66	6.82	5.91

4/15 soil nitrate = 40.0 ppm

Table 2. Trial No. 2. Yield evaluation nitrogen uptake on May 27

Treatment	Total N lbs/A at planting	Fresh (lbs/A)	Fresh (tons/A)	Dry (lbs/A)	%N	lbs N/A
Ammonium sulfate	90	35,737.6	17.9	2,069.0	5.55	114.8
Ammonium sulfate + nitrapyrin 1.0 lb a.i./A	90	30,601.2	15.3	1,825.6	5.51	100.9
NovaTec	90	28,643.6	14.3	1,702.2	5.42	92.2
Duration ST	90	31,889.4	15.9	1,876.3	5.59	105.0
SuperU	90	35,653.9	17.8	2,019.6	5.65	114.4
Ammonium sulfate (+ topdress 70 lbs N/A)	90	35,804.5	17.9	2,027.8	5.97	121.1
Grower Standard (Urea + ammonium sulfate)	160	37,143.0	18.6	2,131.8	5.72	122.0
Untreated	0	19,441.5	9.7	1,324.9	4.98	66.1
Pr>F treat		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
LSD $_{0.05}$		3198.5	1.6	157.0	0.25	11.2

Table 2. Continued. Soil mineral nitrogen evaluations over the crop cycle on four dates.

Treatment	Total N lbs/A at planting	Soil ammonium-N ppm					Soil nitrate-N ppm				
		Apr 30	May 5	May 11	May 19	May 26	Apr 30	May 5	May 11	May 19	May 26
Ammonium sulfate	90	25.7	3.8^{CDE}	1.3^{AB}	4.2^{C}	4.8^{BC}	18.8	19.4^{B}	12.7^{B}	8.0^{B}	4.1^{A}
Ammonium sulfate + nitrapyrin 1.0 lb a.i./A	90	25.1	8.7^{AB}	3.3^{AB}	11.8^{B}	14.0^{AB}	10.8	12.5^{D}	7.6^{C}	4.4^{C}	2.0^{CD}
NovaTec	90	25.6	17.1^{A}	2.5^{A}	17.5^{AB}	16.1^{A}	10.6	14.5^{D}	6.5^{C}	3.7^{C}	2.4^{CD}
Duration ST	90	7.1	1.7^{DE}	0.8^{CD}	12.9^{B}	3.7^{C}	13.1	12.4^{D}	6.9^{C}	5.4^{C}	2.9^{BC}
SuperU	90	19.9	2.9^{CDE}	1.4^{CD}	3.2^{C}	2.5^{C}	15.7	24.0^{BC}	17.8^{AB}	5.2^{C}	3.5^{AB}
Ammonium sulfate (+ topdress 70 lbs N/A)	90	30.0	3.8^{CD}	1.1^{ABC}	30.7^{A}	13.1^{AB}	16.1	16.7^{C}	11.6^{B}	11.4^{A}	7.7^{A}
Grower Standard (Urea + ammonium sulfate)	160	31.1	4.1^{BC}	1.1^{BC}	3.2^{C}	5.3^{BC}	22.3	37.9^{A}	29.2^{A}	10.6^{AB}	7.8^{A}
Untreated	0	4.4	0.8^{E}	0.6^{D}	3.8^{C}	3.3^{C}	5.7	6.9^{E}	3.1^{D}	4.2^{C}	1.4^{D}
Pr>F treat		0.0005	<0.0001	0.0025	<0.0001	0.0034	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
$LSD_{0.05}$		11.9	***	***	**	**	5.5	***	***	**	***

Table 3. Trial No. 3. Mizuna yield evaluation and nitrogen uptake on October 19.

Treatment	Total N lbs/A	Fresh (lbs/A)	Fresh (tons/A)	Dry (lbs/A)	%N	lbs N/A
NovaTec	120	25,460.8	12.73	1,793.3	7.34	123.9
Duration ST	120	27,955.0	13.98	1,922.4	7.54	135.5
Grower's standard	180	27,775.1	13.88	1,808.6	7.00	117.5
Pr>F treat		0.3294	0.3287	0.4183	0.1483	0.2962
$LSD_{0.05}$		NS	NS	NS	NS	NS

Table 4. Trial No. 3. Soil mineral nitrogen evaluations over the crop cycle of mizuna.

Treatment	Total N lbs/A	Soil Ammonium-N ppm				Soil Nitrate-N ppm				Total Mineral-N ppm			
		Sept 23	Oct 5	Oct 12	Oct 19	Sept 23	Oct 5	Oct 12	Oct 19	Sept 23	Oct 5	Oct 12	Oct 19
NovaTec	120	0.2	113.5	63.3	15.9	28.5	45.7	39.2	18.5	28.7	159.2	102.5	34.5
Duration ST	120	0.2	7.6	13.0	1.3	28.5	61.3	44.7	20.4	28.7	68.9	57.8	21.7
Grower's standard	180	0.2	1.0	0.9	0.6	28.5	25.1	8.1	3.3	28.7	26.1	9.0	3.8
Pr>F treat		NA	NA	NA	0.0007	NA	NA	NA	0.0028	NA	NA	NA	0.0019
LSD $_{0.05}$		NS	NS	NS	4.0	NS	NS	NS	6.2	NS	NS	NS	9.1

Table 5. Trial 4. Biomass, yield and nitrogen uptake evaluations and soil mineral nitrogen evaluations over the crop cycle.

Treatment	Fertilizer Applied lbs N/A	Water Applied acre inches	Biomass evaluation[1] Oct. 20			Commercial Harvest[2] Oct. 28 lbs/A	Soil Nitrate-N ppm				
			Fresh wt lbs/A	Dry wt lbs/A	N uptake lbs/A		Sept 23	Sept 29	Oct 5	Oct 12	Oct 20
Grower Standard	180.3	5.37	17,070.3	1028.1	65.8	8,404.4	41.5	41.3	56.4	37.2	27.5
CropManage	116.0	5.45	17,270.8	1051.4	64.4	7,986.5	36.9	35.1	37.9	23.7	7.2

1 – Biomass was collected from nearly all above-ground plant material; 2 – commercial harvest clipped the top of the spinach plant.

Table 6. Summary of soil nitrate, fertilizer and irrigation water applied to spinach.

	Grower Standard				CropManage			
Date	Soil NO_3-N ppm	Fertilizer lbs N/A	Irrigation ac in	Comment	Soil NO_3-N ppm	Fertilizer lbs N/A	Irrigation ac in	Comment
Sept 23	36.8	64.0			31.6	64.0		
Sept 26			1.6	Germination irr.			1.6	Germination irr.
Sept 28			1.3	Germination irr.			1.3	Germination irr.
Sept 29	33.2				27.4			
Oct 2		64.2	0.7			0.0	0.6	
Oct 5	36.8				28.9			
Oct 12	18.4				10.5			
Oct 13		53.5	1.1			53.5	1.2	
Oct 14			0.7				0.7	
Oct 20	27.5			Biomass eval.	7.2			Biomass eval.
Oct 28				Comm. harvest				Comm. harvest
Total		180.3	5.37			117.5	5.45	