

## 2014 Spinach Nitrogen Fertilizer Evaluations

Richard Smith and Tricia Love, Farm Advisor and Staff Research Associate  
University of California Cooperative Extension, Monterey County

**Summary:** Typically in the first crop of the year, the soil nitrate levels are low due to leaching by the winter rains; however, following the warm/dry winter, little leaching occurred and resulted in high soil nitrate. There was no statistical difference in yield among the fertilizer treatments in three trials: 2 on spinach and 1 on baby lettuce. However, there were significant differences in the soil ammonium levels among treatments. Nitrapyrin, Novatec and SuperU had higher soil ammonium levels in one trial than the equivalent amount of N applied as ammonium sulfate. This may indicate that these materials have the ability to improve the retention of N in the soil because it is in a form that can adsorb to the negative charges on clay and organic matter and thereby resist leaching for a period of time that presumably would be longer than untreated ammonium fertilizer.

**Methods: Trial No. 1:** The trial was conducted on a commercial spinach production field with a cooperating grower near Castroville. The soil at the site was Salinas clay loam. This was the first crop of the season on this block. Each plot was one 80-inch bed wide by 20 feet long with four replications and laid out in a randomized complete block design. All fertilizer except for the 160 lbs/A ammonium sulfate (AS) treatment was applied prior to planting and mulched into the bed with the bed shaper on May 5. The 160 lbs N/A AS treatment had 120 lbs applied and incorporated as described above and 40 lbs applied as a dry topdress on May 27. The spinach variety 'Piano' was seeded on May 6 and was watered on May 9. Nitrapyrin was applied two ways: 1) treated AS granules at the rate of 0.5 lb ai/A and 2) mixed with UN 32 liquid fertilizer and sprayed on the bedtop; both were mulched into the bedtop as described above. Novatec is AS treated with DMPP. Duration ST is polymer coated urea (44% N) and SuperU is DCD treated urea prills. The spinach was harvested on June 10 (32 days after the first germination water) by hand harvesting an area 0.5 m<sup>2</sup> in each plot. The harvested spinach was weighed and a subsample was dried, ground and sent to the UC Davis analytical laboratory for total nitrogen analysis. **Trial No. 2:** The trial was conducted on a commercial baby lettuce production field with a cooperating grower south of Gonzales. The soil at the site was Mocho silt loam. Each plot was one 80-inch bed wide by 30 feet long with four replications and laid out in a randomized complete block design. All materials were spread on the bedtop prior to planting on September 2 and mulched into the soil the bed shaper the same day. The trial was planted with green romaine lettuce on September 4 and the first sprinkler applied on September 6. The baby lettuce was harvested on October 8 (32 days after the first germination water) by hand harvesting an area 0.5 m<sup>2</sup> in each plot. The harvested lettuce was weighed and a subsampled was dried, ground and sent to the UC Davis analytical laboratory for total nitrogen analysis. **Trial No. 3:** The trial was conducted on a commercial spinach production field with a cooperating grower north of Salinas. The soil at the site was Chualar loam. This was the second crop of the season. Each plot was one 80-inch bed wide by 20 feet long with four replications laid out in a randomized complete block design. All materials were spread on the bedtop on September 4 and mulched into the soil the same day. The spinach variety 'Piano' was seeded on September 6 and first water was started on September 7. The spinach was harvested on October 6 (30 days after the first germination water) by hand harvesting an area 0.5 m<sup>2</sup> in each plot. The harvested spinach was weighed and a subsample was dried, ground and sent to the UC Davis analytical laboratory for total nitrogen analysis.

**Results: Trial No. 1:** The May 5 soil sampling established a baseline of soil mineral N; soil ammonium levels were 1.5 ppm on this date, but soil nitrate levels were 52.5 ppm (Table 1). The high soil nitrate levels were probably the result of the dry/warm winter weather that allowed for mineralization over the winter and little leaching of nitrate. The May 13 soil sampling date showed a dramatic increase in soil ammonium levels in all treatments except Duration ST, UN32 + nitrapyrin and the untreated control; the high soil nitrate levels generally declined on this date. On the May 19 soil sampling, Novatec and SuperU had the highest ammonium levels followed by AS+nitrapyrin and AS at 160 lbs N/A; soil nitrate levels declined to 28.7 ppm in the untreated control and were significantly higher in all other treatments. On the May 27 sampling date ammonium levels in all treatments had returned to background levels except for SuperU which was significantly higher; all treatments had significantly higher soil nitrate than the untreated control except for Duration ST. On the June 3 sampling date the 160 lb N/A AS treatment had the highest ammonium treatment which was probably due to the topical application made on May 27; the soil nitrate levels in the untreated control had dropped to 5.4 ppm and all other treatments except UN32+nitrapyrin and Duration were significantly higher. On the June 9 sampling date the 160 lbs N/A AS treatment and Novatec had the highest ammonium levels followed by AS+nitrapyrin and Duration ST; soil nitrate levels had declined and only AS+nitrapyrin, Novatec, SuperU and 160 lbs N/A AS had elevated levels. All treatments had higher yield than the untreated control, but there were no differences among treatments. UN32+nitrapyrin had lower percent N and dry and fresh weight. This may provide evidence that this method of applying nitrapyrin may not be effective for spinach production. **Trial No. 2:** On the September 24 soil sampling date Novatec had significantly greater soil ammonium levels (Table 2); soil nitrate levels were higher in the Duration ST and AS treatment. On the October 8 soil sampling Novatec also had the highest ammonium levels; soil nitrate levels were significantly higher in the Novatec, Duration ST and AS treatments. There were no significant differences in yield in this trial. **Trial No. 3:** On all of the soil sampling dates (Sept 15 to Oct 6) the soil ammonium levels were significantly higher in the AS+nitrapyrin and Novatec treatments than the AS treatment (Table 3). Soil nitrate levels at this trial site were 63.5 at the beginning of the trial and declined to 21.8 ppm by the end of the trial; the high residual soil nitrate levels made detecting differences among the treatments difficult. There were no significant differences in yield among the treatments.

Table 1. Trial No. 1. Yield, nitrogen content of spinach on June 10 and mineral nitrogen in the soil on six dates.

Treatment	Amount lbs N/A	Fresh (lbs/A)	Fresh (tons/A)	Dry (lbs/A)	%N	lbs N/A in spinach	mg ammonium-N/kg soil					
							May 5*	May 13	May 19	May 27	June 3	June 9
AS nitrpyrin	120 0.5 ai/A	34135.1	17.1	1962.8	5.9	115.0	1.5	28.8 <sup>A</sup>	14.1 <sup>B</sup>	1.7 <sup>B</sup>	1.9 <sup>BC</sup>	7.5 <sup>B</sup>
UAN 32 nitrpyrin	120 0.5 ai/A	29958.0	15.0	1685.3	5.4	91.4	1.5	6.1 <sup>B</sup>	3.1 <sup>C</sup>	1.3 <sup>B</sup>	1.7 <sup>BC</sup>	2.1 <sup>C</sup>
Novatec	120	33917.9	17.0	1869.5	5.9	110.6	1.5	37.6 <sup>A</sup>	23.9 <sup>A</sup>	3.1 <sup>B</sup>	2.5 <sup>B</sup>	13.1 <sup>A</sup>
Duration ST	120	32547.8	16.3	1797.7	5.7	102.1	1.5	8.7 <sup>B</sup>	5.8 <sup>C</sup>	2.1 <sup>B</sup>	1.7 <sup>BC</sup>	5.8 <sup>B</sup>
SuperU	120	34352.3	17.2	1863.5	5.8	107.8	1.5	24.1 <sup>A</sup>	23.1 <sup>A</sup>	7.8 <sup>A</sup>	1.9 <sup>BC</sup>	1.6 <sup>C</sup>
AS	120	34235.3	17.1	1927.6	5.7	109.6	1.5	23.8 <sup>A</sup>	5.1 <sup>C</sup>	1.3 <sup>B</sup>	1.6 <sup>C</sup>	2.0 <sup>C</sup>
AS	160	34486.0	17.2	1903.1	6.0	115.0	1.5	23.0 <sup>A</sup>	8.6 <sup>BC</sup>	1.6 <sup>B</sup>	4.6 <sup>A</sup>	15.5 <sup>A</sup>
Untreated	0	19231.3	9.6	1130.4	5.4	60.5	1.5	1.7 <sup>C</sup>	1.8 <sup>C</sup>	1.5 <sup>B</sup>	1.5 <sup>C</sup>	2.0 <sup>C</sup>
Pr>F treat	---	<0.0001	<0.0001	<0.0001	0.0475	<0.0001	NA	<0.0001	<0.0001	0.0004	0.0002	<0.0001
Pr>F block	---	0.5461	0.5639	0.4885	0.4857	0.3712	NA	0.8055	0.064	0.4343	0.6673	0.3553
LSD <sub>0.05</sub>	---	5148.6	2.5	273.6	0.4	18.1	NA	---	---	---	---	---

Table 1. continued

Treatment	Amount lbs N/A	mg nitrate-N/kg soil					
		May 5	May 13	May 19	May 27	June 3	June 9
AS nitrpyrin	120 0.5 ai/A	52.5	41.8	48.9	41.7	25.5	14.5
UAN 32 nitrpyrin	120 0.5 ai/A	52.5	54.2	54.9	46.4	14.6	5.6
Novatec	120	52.5	48.3	57.4	44.2	29.2	14.1
Duration ST	120	52.5	39.2	41.1	28.8	15.8	10.2
SuperU	120	52.5	47.9	70.0	78.0	38.4	17.9
AS	120	52.5	39.0	51.7	39.3	25.1	8.4
AS	160	52.5	42.3	55.2	43.7	32.4	24.6
Untreated	0	52.5	36.8	28.7	24.3	5.8	5.1
Pr>F treat	---	NA	0.0777	0.0040	<0.0001	0.0100	0.0006
Pr>F block	---	NA	0.1162	0.1353	0.1007	0.2555	0.4878
LSD <sub>0.05</sub>	---	NA	NS	17.1	9.7	16.3	7.9

Table 2. Trial No. 2. Yield, nitrogen content of baby lettuce on October 8 and mineral nitrogen in the soil

Treatment	Amount lbs N/A	Fresh (lbs/A)	Fresh (tons/A)	Dry (lbs/A)	%N lettuce	lbs N/A lettuce	mg ammonium-N/kg soil		mg nitrate-N/kg soil	
							Sept. 24	Oct. 8	Sept. 24	Oct. 8
Novatec	120	22233.2	11.1	1490.6	4.77	71.06	6.8	7.0	45.4	35.3
Duration ST	120	24884.3	12.4	1422.1	5.06	72.26	1.7	3.4	56.0	32.9
AS	120	21854.5	10.9	1387.6	4.47	62.13	1.4	0.5	70.1	35.7
Untreated	0	20807.4	10.4	1223.1	3.74	45.99	0.3	0.2	33.6	3.3
Standard	187	26109.5	13.1	1380.0			0.4	0.3	15.6	4.3
Pr>F treat		0.5066	0.4941	0.1831	0.0027	0.0296	0.0003	0.0185	0.0043	0.0447
Pr>F block		0.9775	0.9820	0.7304	0.1792	0.7409	0.262	0.3142	0.0055	0.2852
LSD <sub>0.05</sub>		NS	NS	NS	0.48	16.95	2.3	4.1	24.7	27.5

Table 3. Trial No. 3. Yield, nitrogen content of spinach on October 6 and mineral nitrogen in the soil

Treatment	Amount lbs N/A	Fresh (lbs/A)	Fresh (tons/A)	Dry (lbs/A)	%N spinach	lbs N/A spinach	mg ammonium-N/kg soil				mg nitrate-N/kg soil			
							Sept. 15	Sept. 26	Oct. 1	Oct. 6	Sept. 15	Sept. 26	Oct. 1	Oct. 6
AS nitrapyrin	80 0.5 ai/A	23475	11.7	1826	6.49	118.50	12.2 <sup>AB</sup>	3.7 <sup>AB</sup>	5.6 <sup>A</sup>	3.7 <sup>A</sup>	61.2	58.8	46.8	29.2
Novatec	80	24411	12.2	1904	6.58	125.28	18.4 <sup>A</sup>	8.2 <sup>A</sup>	7.4 <sup>A</sup>	6.1 <sup>A</sup>	48.2	46.4	36.1	26.4
Duration ST	80	24645	12.3	1835	6.56	120.55	2.5 <sup>D</sup>	2.7 <sup>B</sup>	1.8 <sup>B</sup>	2.8 <sup>A</sup>	63.4	58.4	58.1	42.1
SuperU	80	24210	12.1	1816	6.49	117.78	9.8 <sup>BC</sup>	0.7 <sup>C</sup>	0.3 <sup>C</sup>	0.3 <sup>B</sup>	63.6	57.3	54.7	32.6
AS	80	21637	10.8	1714	6.45	110.66	3.9 <sup>CD</sup>	0.6 <sup>C</sup>	0.3 <sup>C</sup>	0.3 <sup>B</sup>	84.7	69.9	64.8	47.6
Untreated	0	24745	12.4	1849	6.36	117.71	0.7 <sup>E</sup>	0.8 <sup>C</sup>	0.3 <sup>C</sup>	0.3 <sup>B</sup>	63.5	42.7	37.6	21.8
Standard	100	23876	11.9	1861	6.41	119.40	2.0 <sup>DE</sup>	3.4 <sup>B</sup>	2.9 <sup>AB</sup>	0.6 <sup>B</sup>	65.3	57.0	38.5	33.8
Pr>F treat	---	0.7468	0.7410	0.4764	0.2450	0.4583	<0.0001	<0.0001	<0.0001	<0.0001	0.0204	0.0790	0.0288	0.0694
Pr>F block	---	0.0005	0.0005	0.0291	0.2055	0.0303	0.169	0.0137	0.2816	0.2816	0.1071	0.0018	0.1685	0.032
LSD <sub>0.05</sub>	---	NS	NS	NS	NS	NS					17.3	17.4	19.1	17.1