Using the Nitrate Present in Soil and Water in Your Fertilizer Calculations

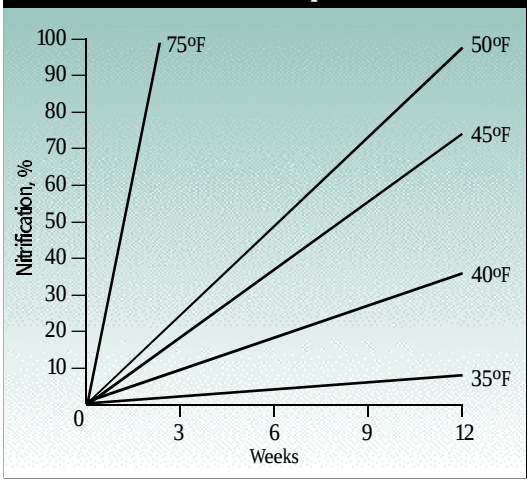
Fact Sheet 4

The information contained in this Fact Sheet is intended to help the grower reduce the amount of nitrogen fertilizer applied. A determination that irrigation water or soil is "high in nitrate" does not necessarily mean that it contains enough nitrate-nitrogen to eliminate the need for additional nitrogen fertilizer. However, by using this Fact Sheet, the grower may be able to replace a portion of the fertilizer normally applied with the nitrate-nitrogen already present in the soil or water.

N Availability

- Nitrate is the form of nitrogen used in a crop's growth cycle.
- Nitrogen that starts as urea or ammonia must go through a conversion to nitrate before it is available to the crop.
- Hydrolysis converts urea to ammonia in 3-5 days. hy•dro•ly•sis \hī-drä-lə-səs\ *n*: a chemical decomposition involving the addition of the elements of water.
- Nitrification converts ammonia to nitrate at a rate that depends on soil temperature (graph). ni•tri•fi•ca•tion \nī-trə-fə-kā-shən\ *n*: the oxidation (as by bacteria) of ammonium salt to nitrite and then to nitrate.

Generalized nitrification rates at various soil temperatures.



Conversion Factors In Water:

1 gallon of water	*weighs*	8.333 lbs
1 cu. ft. of water	*equals*	7.481 gallons
When You Know	***Multiply By***	***To Find***
acre-inches	27,150	gallons
acre-feet	325,850	gallons
When You Know	***Divide By***	***To Find***
gallons	27,150	acre-inches
gallons	325,850	acre-feet
When You Know	***Multiply By***	***To Find***
ppm NO_3	0.226	ppm NO_3-N
ppm NO_3-N	4.43	ppm NO_3

Conversion Factors In Soil:

When You Know	*Multiply By*	*To Find*
ppm NO_3-N	2	lbs N/acre (6" sample)
ppm NO_3-N	4	llbs N/acre (12" sample)
ppm NO_3	0.452	lbs N/acre (6" sample)
ppm NO_3	0.904	lbs N/acre (12" sample)

Equivalents:

1 mg/L	equals	1 ppm
1 unit N	equals	1 lb N/acre

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All of the nitrate-nitrogen present in the soil or water is in a usable form; there are no inhibitors to plant uptake.

Percent Nitrogen Forms in Standard Nitrogen Solutions[i]

	Nitrate	Ammonia	Urea	lbs N/gal[1]	lbs/gal[2]
CAN-17	11.6	5.4		2.15	12.60
AN-20	10.0	10.0		2.10	10.50
UREA-20			20.0	1.87	9.33
UAN-28	7.0	7.0	14.0	2.98	10.66
UAN-32	7.8	7.8	16.4	3.54	11.06

[1]pounds of N per gallon of solution at 60ºF [2]material weight of solution at 60ºF

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Nitrogen Fertilizer Requirements of Cool-Season Vegetable Crops Grown Under California Conditions[ii]				
Crop	Approximate Nitrogen Requirements (lb/acre-week)			
Broccoli[1]	Early Growth 5-15[2]	Mid Season 10-20	Button Formation 15-30	Head Development 10-20
Cabbage	Early Growth 5	Mid Season 35	Curling 40	Heading 55
Celery	Early Growth 5	Mid Season 15	Late Season 25	
Garlic	Early Growth 5	Mid Season 10	Bulbing 15	
Lettuce[1]	Early Growth 5-10	Cupping 10-20	Head Filling 15-30	
Onion	Early Growth 5	Mid Season 15	Bulbing 10	

[1] Values were determined when fertilizer was added through the drip irrigation system and should serve as a general guide, with fertilizer additions being subject to soil/tissue NO_3-N levels.
[2] Higher values represent N needs in low residual N soils and/or under rapid growth (high temperature) conditions.

Conversion Table for Nitrate in Irrigation Water			
Nitrate (NO_3-N) ppm	Nitrate (NO_3) ppm	lb N/acre-inch	lb N/acre-foot
N (NO_3-N)	NO_3 = N x 4.43	lbs N/ac-in = N x 0.23	lbs N/ac-ft = N x 2.71
10	44	2	27
20	89	5	54
30	133	7	81
40	177	9	108
50	221	11	136
60	266	14	163
70	310	16	190
80	354	18	217
90	398	20	244
100	443	23	271
120	531	27	325
140	620	32	380
160	708	36	434
180	797	41	488
200	885	45	542
225	997	52	610
250	1107	56	678
The USEPA drinking water maximum contaminant level (MCL) for NO_3-N is 10 ppm; the MCL for NO_3 is 45 ppm.			

Remember to take into account the efficiency of your irrigation system when crediting irrigation water N.

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[i] *Western Fertilizer Handbook: Second Horticulture Edition*. California Fertilizer Association.
[ii] *Production Guide: Nitrogen and Water Management for Coastal Cool-Season Vegetables*, 1998. G.S. Pettygrove, S.R. Grattan, B.R. Hanson, T.K. Hartz, L.E. Jackson, T.R. Lockhart, K.F. Schulbach, and R. Smith. Publication 21581, Division of Agriculture and Natural Resources, University of California, Oakland CA. This publication can be ordered from ANR Communication Services at 800-994-8849 or on the Internet at http://commserv.ucdavis.edu/ucce/.

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Soil Nitrate-Nitrogen Quick Test

Supplies needed for this test:

1. Two 50 ml centrifuge tubes/individual field
2. 5.6 grams of Calcium Chloride to be added to 1 gallon of distilled water
3. Nitrate test strips

Procedure:

1. Collect 8-10 random samples from the field. Collect core samples to a depth of 12 inches (active root depth). Do Not include top 2 inches of soil since it may be high in N but too dry for active root growth. Mix samples thoroughly in a bucket.
2. Fill tube to the 30 ml level with calcium chloride solution.
3. Add soil to the tube until the level rises to 40 ml. Cap tube and shake vigorously. Let sit until particles settle out. Time will vary depending on clay conten
4. When solution is reasonably clear dip test strip into the solution for 1 second, shake off excess, and wait 60 seconds. Compare color with color chart.
5. To minimize variability run two replications.

Interpretation/Calculations: (mg/l is the same as ppm, 1:1)

1. The test strips measure NO_3 ppm in the solution. To approximate conversion of reading to ppm NO_3-N for dry soils requires a correction factor based on soil texture and moisture. Use the formula ⇨ **Test strip reading (ppm NO_3) ÷ correction factor = ppm NO_3-N in dry soil**

example: You get a test strip reading of 30 ppm NO_3 and your ground is moist sandy loam (~2.15)
Your NO_3-N in dry soil would be ***13.9 ppm***

Correction Factor		
Soil Texture	**Moist Soil**	**Dry Soil**
Sand	2.3	2.6
Loam	2	2.4
Clay	1.7	2.2

NOTE: Soils less than 10 ppm NO3-N would be considered quite low, levels above 20 ppm would have enough availble nitrogen to meet immediate crop needs. Caution: low soil NO3-N values late in the cropping season may not indicate insufficient nitrogen; it may just indicate highly efficient crop uptake. Tissue testing (petiole sample) would be required to confirm low nitrogen status.

2. Use the number generated in step 1 (13.9) to convert Nitrate-N in the soil to existing pounds of available nitrogen/acre in a 12" sample. To do this multiply the correction factor by 4…..13.9 x 4 = **55.6 pounds of nitrogen per acre available to your crop**

NOTE: If you take soil samples to a depth of 6 inches instead of 12 inches (as described above) you will need to multiply your reading by 2 instead of 4.