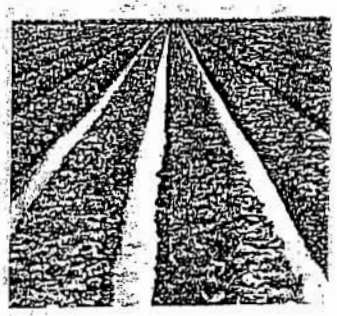
APPENDIX 8

On-Farm Nitrogen Determination in Plant Sap, Soil, and Water



Monterey County
Water Resources
Agency

Santa Clara Valley
Water District

Pajaro Valley
Water Management
Agency

Soil NO_3-N "Quick Test" Protocol

Item No. 28
December 4-5, 2008 Meeting
Pajaro Valley Water Mgmt Agency/
Watsonville Water Reclam Permit
Attachment 5

Plant Sap N Determination

Procedure

1. Sample a minimum of 20 plants from each field or management unit. See the chart below for the plant part to sample for each crop type. Always sample during the same time of day (preferably between 8 a.m. and 2 p.m.) to minimize variability.

Crop	Plant Part
Broccoli	Whole petioles (leaf stem) of youngest fully expanded leaf
Brussels Sprouts	Mid-rib of youngest fully expanded leaf
Cabbage	Mid-rib of wrapper leaf
Cauliflower	Mid-rib of youngest fully expanded leaf
Celery	Portion below first node of recently expanded leaf
Lettuce	Mid-rib of youngest fully expanded leaf
Spinach	Petiole of youngest mature leaf
Onion	Roots (washed with water and hand dried)

2. Avoid moisture loss from the tissue samples by keeping them in plastic bags on ice until analysis. Samples can be stored on ice for 6-8 hours without significantly affecting nitrate concentration.
3. Extract the sap from the selected plant part using a garlic press or plant press. Use the same amount of pressure to extract the sap from each of the 20 samples into a clean container. Mix and allow the sap to come to room temperature before analyzing.
4. A Cardy® nitrate meter or Merck Reflectoquant® Analysis System can be used to analyze the sap. Follow the respective meter directions for analysis. Samples may need to be diluted with distilled water if the nitrate concentration exceeds the testing capacity of the meter.

Soil NO_3-N "Quick Test" Protocol

Procedure

1. Dissolve 5.6 grams of $CaCl_2$ in 1-gallon of distilled water to make 0.01 M $CaCl_2$ solution.
2. In a clean container, collect a composite soil sample that is representative of the main active root zone of the crop. Don't include the top 2 inches of soil since it may be high in NO_3-N but too dry for active root growth. Blend soil sample thoroughly.
3. Fill two 50-mL centrifuge tubes to the 30-mL level with the 0.01 M $CaCl_2$ solution. The calcium will help the soil settle to the bottom of the tube. (Duplicate samples--two tubes for each soil sample--are tested for each field to minimize the variability inherent in soil sampling.)
4. Add field-moist soil to the tube until the liquid level rises to 40 mL. Cap tightly and shake vigorously until the soil is thoroughly dispersed. Let sit until soil settles.
5. When the solution is reasonably clear, dip a Merckoquant® nitrate test strip into the solution for one second, shake off excess solution, and wait 60 seconds. Estimate nitrate concentration using the color chart provided.

Interpretation

Nitrate-nitrogen (NO_3-N) sufficiency values for dry tissue and fresh sap samples

Crop	Growth Stage	NO_3-N Concentration	
		Dry Tissue[1]	Fresh Sap
Broccoli	mid-growth	10,000 - 20,000	1,000 - 1,600
	button formation	8,000 - 15,000	800 - 1,200
	preharvest	5,000 - 8,000	600 - 1,000
Brussels Sprouts	mid-growth	9,000	
	late growth	4,000	
Cabbage	10-12 leaves	8,000	
	mid-growth (folding)	6,000	1,200 - 1,500
	early heading	4,000	1,000 - 1,200
	preharvest	3,000	700 - 900 (mid heading)
Cauliflower	mid-growth (folding)	7,000	1,000 - 1,600
	button formation	6,000	
	curd development	2,500	700 - 1,000
	preharvest	1,500	500 - 800
Celery	mid-growth	7,000 - 10,000	600 - 800
	preharvest	6,000 - 8,000	400 - 600
Lettuce	early head formation	7,000 - 12,000	400 - 600
	preharvest	6,000 - 10,000	350 - 500
Spinach	mid-growth	8,000	
Onion	early bulbing	5,000 - 7,000	350 - 500

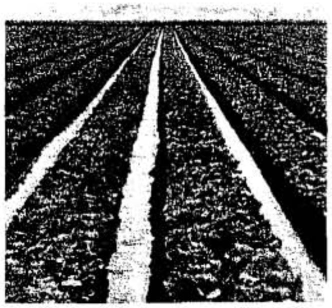
[1]Lab analyzed.

Interpretation

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.

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



Monterey County Water Resources Agency

Santa Clara Valley Water District

Pajaro Valley Water Management Agency

Pocket Guide

1. N Availability
2. Conversion Factors
3. Percent Nitrogen
4. N Requirements
5. N in Irrigation Water
6. Sample Calculations

La información que se presenta en este Guía de Bolsillo tiene como propósito ayudar a los agricultores a reducir la cantidad de fertilizantes nitrogenados en sus aplicaciones. Cuando las pruebas del agua de riego o de los suelos resultan "altas en nitratos," no significa necesariamente que contienen suficiente nitrógeno como para eliminar las fertilizaciones nitrogenadas adicionales. Sin embargo, siguiendo las recomendaciones que se presentan en este Guía de Bolsillo, los agricultores pueden reponer porciones de sus aplicaciones normales de fertilizantes utilizando los datos del nitrógeno-nitratado que se sabe están presentes de antemano en sus suelos o aguas.

Monterey County Water Resources Agency

Agencia de Recursos del Agua del Condado de Monterey Administra, proteje y mejora la cantidad y calidad del agua y provee servicios específicos en el control de inundaciones para las generaciones presentes y futuras del Condado de Monterey.

893 Blanco Circle
Salinas, California 93901
(831) 755-4860
http://www.mcwra.co.monterey.ca.us

Santa Clara Valley Water District

Distrito de Riego del Valle de Santa Clara Es la agencia administrativa de las fuentes de agua que satisface las necesidades de protección contra inundaciones y las del uso de agua disponible paro los 1.7 millones de residentes del Condado de Santa Clara.

5750 Almaden Expressway
San Jose, California 95118
(408) 265-2600
http://www.scvwd.dst.ca.us

Pajaro Valley Water Management Agency

La oficina local, instituída por el estado, responsable por la administración efectivay eficiente de los recursos hídricos en la cuenca costera de Pajaro Valley.

36 Brennan Street
Watsonville, CA 95076
(831) 722-9292
http://www.pvwma.dst.ca.us

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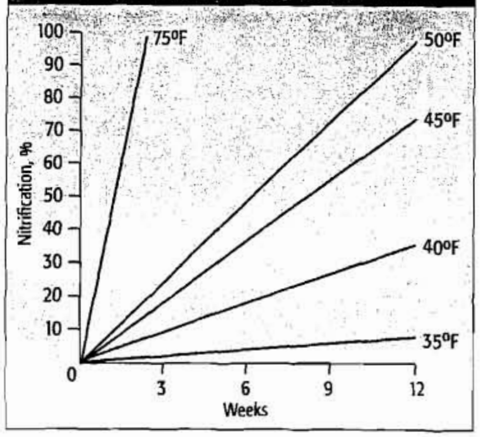
1. N Availability

- 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.



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

2. Conversion Factors

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	lbs 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

Percent Nitrogen Forms in Standard Nitrogen Solutions[1]					
	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 60°F [2]material weight of solution at 60°F

[1] *Western Fertilizer Handbook: Eighth Edition*. California Fertilizer Association.

4. N Requirements

Nitrogen Fertilizer Requirements of Cool-Season Vegetable Crops Grown Under California Conditions[ii]				
Crop	Approximate Nitrogen Requirements (lbs/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.

[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/.

5. N in Irrigation Water

Conversion Table for Nitrate in Irrigation Water			
Nitrate (NO_3-N) ppm	Nitrate (NO_3) ppm	lbs N/acre-inch	lbs N/acre-foot
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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.

6. Sample Calculations

Conversion Factors in Soil:

- An analysis of a soil sample from the top 12 inches indicates that there are 5 mg/L NO_3-N. Using the conversion factors on page 2, multiply NO_3-N by 4 to get lbs N/acre (12" sample).
- Therefore, there are 20 lbs N/acre in the top 12 inches of soil, potentially available to the crop.

Conversion Factors in Water:

- An analysis on a water sample indicates that your irrigation water contains 100 mg/L NO_3.

① mg/L NO_3 * 0.226 = mg/L NO_3-N (page 2)
100 * 0.226 = 22.6 mg/L NO_3-N

② mg/L NO_3-N * 0.23 = lbs N/ac-in (page 5)
22.6 * 0.23 = 5.2 lbs N/ac-in

- Therefore, for every inch of irrigation water applied, 5.2 lbs of potentially useable nitrogen is applied. If your irrigation system's distribution uniformity is 70%, then you can count on 5.2 * 0.70 lbs-N/ac-in or 3.6 lbs of N for every inch of water applied.

Nitrogen in Standard Fertilizer Solutions:

- After taking into account how much nitrogen is already in the soil at the crop's active root zone, and how much N is being applied in each irrigation, let's say you determine that you need an additional 20 lbs N/acre. Use the table on page 3 to determine how much CAN17 fertilizer, for example, is required to supply the desired amount.

① %Nitrate + %Ammonia + %Urea = %N in product
11.6 + 5.4 + 0 = 17% N in CAN17

② lbs-N/ac ÷ %N = lbs. of product per acre
20 ÷ 0.17 = 117.65 lbs of CAN17 per acre

OR

③ lbs-N/ac ÷ lbs-N/gal = gallons product per acre
20 ÷ 2.15 = 9.30 gallons of CAN17 per acre