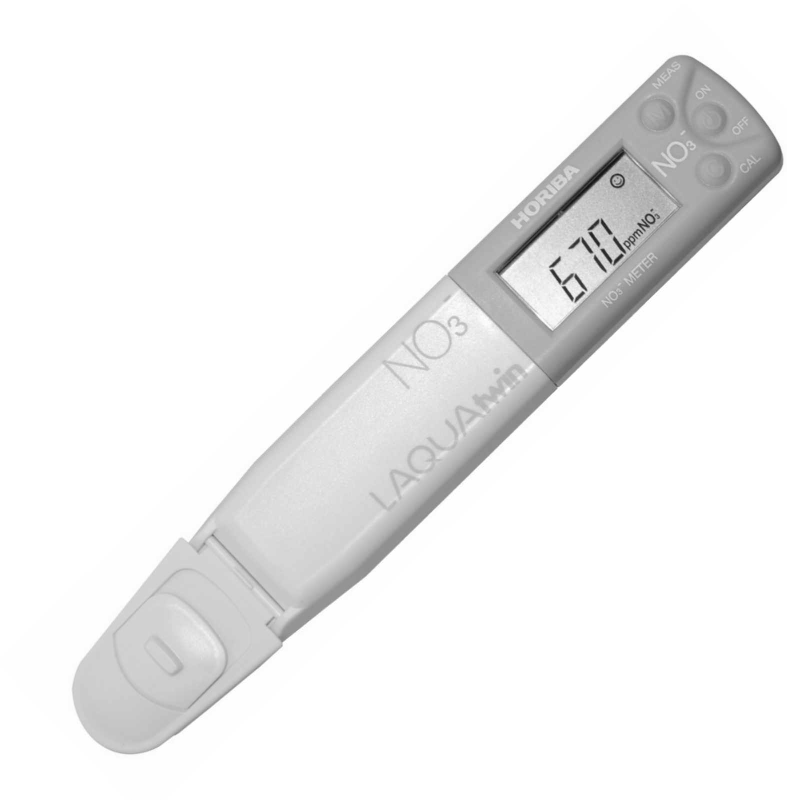
LAQUA Twin
Nitrate NO_3^- Meter

SUPPLEMENT MANUAL

Item 2305GL



Spectrum® Technologies, Inc.

Contents

Instructions for operating the LAQUA Nitrate Meter are published in a separate document. This supplemental manual provides information on using the meter for soil and tissue sampling as well as expected nitrate ranges for common crops.

Calibrating Solutions

NO_3^- (nitrate) versus NO_3^--N (nitrate-nitrogen)

The sensor of the LAQUA meter measures NO_3^- nitrate ion activity similar to the way a pH sensor measures H^+ ion activity. Decide whether you desire the meter LCD display to express the sample concentration as NO_3^- nitrate or NO_3^--N nitrate-nitrogen. (Note: this is similar to referencing length as 6 in. or ½ ft.). Laboratory analysis and university guidelines are generally expressed as NO_3^--N nitrate-nitrogen.

To convert NO_3^--N nitrate-nitrogen to NO_3^- nitrate:

multiply	or	divide
$NO_3^-\text{-N} \times 4.42 = NO_3^-$		$NO_3^-\text{-N} / .226 = NO_3^-$

Therefore:

2000 ppm NO_3^- nitrate = 450 ppm NO_3^--N nitrate-nitrogen
150 ppm NO_3^- nitrate = 34 ppm NO_3^--N nitrate-nitrogen

The following table shows the concentrations of the various calibration standards in each unit of measurement.

Description	**ppm NO_3^-**	**ppm NO_3^--N**
#2311 450 ppm NO_3^--N *	2000	450
#2312 34 ppm NO_3^--N *	150	34
#2336 450 ppm NO_3^--N **	2000	450
#2334L 34 ppm NO_3^--N **	150	34

*** For use with plant sap, water and nutrient solutions.**
**** For use with soil samples (contains aluminum sulfate).**

Preparing Soil Samples

Sample Collection

Collect at least 15 to 20 core samples from an area not exceeding ten acres by using a Z pattern. Areas having different soil types or management histories should be sampled separately. Sample the top 12 inches of soil. Some universities recommend sampling the top 24 inches in 12 inch increments. Contact your county extension agent for recommendations. Care should be taken to ensure that soil samples are not biased by the presence of rows or bands of fertilizer.

Soil Preparation

Samples should be dried within 24 hours of collection to minimize changes in NO_3^--N concentrations. Before drying, crumble the soil to avoid large clods that will be difficult to crush when dry. The samples should then be dried by spreading on a thin layer of newspaper at least 3 pages thick and placing overnight in a warm spot with good air movement. Soil will dry in a few hours if placed in a sunny location exposed to the wind. If dried indoors, 24 to 48 hours may be required. Indoor drying time can be reduced with the use of a fan. For oven drying, spread a thin layer of soil on a cookie sheet or pie plate. Place it in an oven set to no more than 250°F with the door slightly ajar. Consider the soil dry when it crumbles rather than compacts under pressure. After drying, crush the soil by using a block of wood or other suitable device. Crush until the soil particles are the size of BB's or smaller. Sift with a flour sifter or other 10 mesh screen. Mix soil thoroughly.
Soil testing of mineral soil requires the Soil Test Kit (item #2330). Be sure you are using the soil standard solutions (item nos. 2334L and 2336) when calibrating the meter for soil tests. Do not use the calibration standards for water/plant sap (See **Calibrating Solutions**, p. 10).

Sample Preparation

1. Measure 2 level measuring spoons (30 ml) full of dry soil into the soil sample cup.

2. Add 2 (30 ml) measuring spoons of the soil extractant to the soil.

3. Mix the soil and the solution by stirring with the spoon for at least 2 minutes, making sure the soil sample is thoroughly mixed. Let stand for 5 minutes

4. Fold a circular filter in half ‘twice’ and open it up to form a cone. Place it in the soil suspension as far as possible. The filtration will take place from the outside of the filter to the inside.

5. As soon as sufficient filtrate accumulates in the filter, use the small pipette to transfer the soil extract onto the sensor of the LAQUA meter.

6. Read the value from the digital display after it has stabilized (30 - 45 sec.). Subtract 34 from the display value. This accounts for the 34 ppm NO_3^- in the extractant solution. For lbs/acre, multiply by 4 for a sampling depth of 12 inches. Note: For soils very low in nitrate, it is possible to get sensor readings less than 34.

7. Rinse sensor and blot dry. Display should read close to “0” with distilled water on it, if not rinse again.

Preparing Soil-less media

Sample collection

1. Collect sample just before plants are irrigated.
2. Avoid the top layer of media with no roots.
3. Collect root media from the bottom ⅔ of the pot.
4. Take samples from 10 or more plants distributed in the sample population.
5. When a sufficient amount of root media is collected, mix the sample.

Sample Preparation and Analysis
1:2 Extraction method

Measure a known volume of root media in a beaker or cup (usually 50 to 100 ml or ¼ to ½ cup). Fill firmly so it is compressed as it was in the pot. Be consistent when measuring. DO NOT lightly fill or heavily pack the beaker. Place the sample into a cup or beaker.

Add 2 equal volumes of distilled water into the cup, mix the sample and wait 10 minutes. Measure the nitrate after sieving out the large particles. The nitrate level can be read directly from the slurry.

Saturated media extract method

Place 300 to 500 ml (1 to 2 cups) of root media sample in a cup or beaker.

Slowly add distilled water, constantly stirring the sample with a spatula or knife. Add enough distilled water so that the sample behaves like a paste with the surface glistening with water, but with no free water on the surface of the sample.

After 15 minutes, add more water if needed.

Extract the solution from the media using a pipette, Buchner funnel, side arm, flask and vacuum pump, filter bag or sieve. Make any additional measurements (such as EC) using the extracted solution. Table 2 gives a general idea of the nitrate levels to look for in the extracted solution.

Media Type	**ppm NO_3^--N in extract**
Seedlings	40 - 70
Young pot and foliage plants	50 - 90
Pot and bedding plants-growing on	80 - 160
Roses, mums or snapdragons in ground or raised beds	120 - 200
Lettuce and tomatoes in ground beds	125 - 225
Celery transplants	75 - 125

Table 2: Interpretation of Greenhouse Soils: Desirable NO_3^--N concentrations in saturated media extract.

Collecting Tissue Sap

When conducting a test on plant materials, the biggest source of error is due to sampling. This error results when a sample is not representative of the source. Follow these steps to gather and care for your sample:

1.) Do not sample plants which show obvious signs of nutrient deficiency or damage from disease, insects, or chemicals unless these plants are the subject of a study. Plants which have been under stress for a period of time may not give a true picture of the nutrient status of the field.

2.) The leaves or parts of leaves selected should be of the same age and relative position on the plant. The most recently matured leaves should be used. These are the leaves that have stopped expanding in size. The petiole or leaf stem of the leaf or appropriated plant material should be used for the test.

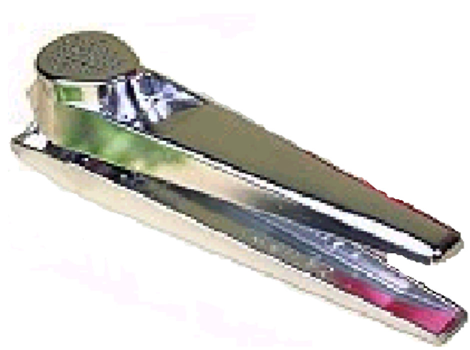
3.) A minimum of 25 petioles or leaves should be collected. This is enough to represent a five to ten acre field if the field is judged to be uniform. Chop up the petioles and mix and sub-sample these pieces for testing. Crops with small, dry petioles, such as strawberries require much larger samples to get enough sap compared to fleshy crops such as tomatoes. Store whole petioles, not leaves, at room temperature for up to 1½ hours or on ice for up to eight hours. Cold petioles should be warmed to room temperature before taking a measurement.

4.) Depending on how succulent the petiole is, use a handheld (p. 9) to squeeze sap from the petioles.

Soil Test Kit Accessories

Description	#2330 Replenishment Kit
Std. Solution 450ppm NO_3^--N (30ml)*	1
Extractant 34ppm NO3⁻-N (1 Liter)*	2
Cups - 8oz.	3
Measuring Spoon (29.5 cc)	1
Pipet	1
Filter Papers	30

* Calibration solutions in soil test kits include $AlSO_4$



Handheld Plant Sap Press
(item #2725)

Petiole NO_3^--N Sufficiency Levels For Drip-Irrigated vegetables
(Source: UC-Davis)

Crop	Growth Stage	Petiole NO_3^--N concentration Dry Tissue	Fresh Sap
Broccoli	Mid growth	10,000 - 20,000	1000 - 1600
	Button formation	8000 - 15,000	800 - 1200
	Preharvest	5000 - 8000	600 - 1000
Cabbage	Cupping	*	1200 - 1500
	Early heading	*	1000 - 1200
	Mid heading	*	700 - 900
Canteloupe	Early flower	12,000 - 15,000	1000 - 1600
	Fruit bulking	8000 - 10,000	800 - 1000
	First harvest	4000 - 6000	700 - 800
Cauliflower	Mid growth	*	1000 - 1600
	Curd development	*	700 - 1000
	Preharvest	*	500 - 800
Celery	Mid growth	7000 - 10,000	600 - 800
	Preharvest	6000 - 10,000	400 - 600
Lettuce	Early head formation	7000 - 10,000	400 - 600
	Preharvest	6000 - 8000	300 - 500
Onion	Bulbs 0.5-1.5 in.	*	350 - 500
Pepper	Vegetative growth	7000 - 10,000	900 - 1200
	Early flower/fruit	5000 - 8000	700 - 1000
	Fruit bulking	5000 - 8000	700 - 1000
	Preharvest	5000 - 7000	700 - 900
Potato	Early vegetative	17,000 - 22,000	1300 - 1600
(Russet Burbank)	Mid tuber/bulking	11,000 - 15,000	900 - 1200
	Late tuber/maturation	6000 - 8000	550 - 700
Sweet Corn	Entire season	*	600 - 700
Tomato	Vegetative growth	10,000 - 14,000	700 - 900
	Early flower/fruit	9000 - 12,000	600 - 800
	Fruit bulking	6000 - 8000	500 - 700
	Preharvest	4000 - 7000	400 - 600
Watermelon	Early flower	12,000 - 15,000	1000 - 1600
	Fruit bulking	8000 - 15,000	700 - 900
	Fruit harvest	5000 - 8000	500 - 700

Petiole NO_3^--N Sufficiency Levels

(Source: University of Florida)

Crop	Growth Stage	NO_3^--N (ppm) Fresh Sap
Cucumber	First blossom	800 - 1000
	Fruits 3-inches long	600 - 800
	First harvest	400 - 600
Broccoli & Collards	Six-leaf stage	800 - 1000
	Just prior to harvest	500 - 800
	At first harvest	300 - 500
Summer Squash	First blossom	900 - 1000
	First harvest	800 - 900
Muskmelon	First blossom	1000 - 1200
	Fruits 2-inches long	800 - 1000
	First harvest	700 - 800
Tomato (field)	First buds	1000 - 1200
	First open flowers	600 - 800
	Fruit 1-inch diameter	400 - 600
	Fruit 2-inch diameter	400 - 600
	First harvest	300 - 400
	Second harvest	200 - 400
Bell Pepper	First flower buds	1400 - 1600
	First open flowers	1400 - 1600
	Fruits half-growth	1200 - 1400
	First harvest	800 - 1000
	Second harvest	500 - 800
Eggplant	First fruit (2-inches long)	1200 - 1600
	First harvest	1000 - 1200
	Mid harvest	800 - 1000
Potatoes	Plants 8-inch tall	1200 - 1400
	First open flowers	1000 - 1400
	50% of flowers open	1000 - 1200
	100% of flowers open	900 - 1200
	Tops falling over	600 - 900

Petiole NO_3^--N Sufficiency Levels (Cont.)

(Source: University of Florida)

Crop	Growth Stage	NO_3^--N (ppm) Fresh Sap
Annual Hill Strawberries (October planting)	November	800 - 900
	December	600 - 800
	January	600 - 800
	February	300 - 500
	March	200 - 500
	April	200 - 500
Watermelon	Vines 6-inches long	1200 - 1500
	Fruit 2-inches long	1000 - 1200
	Fruits half mature	800 - 1000
	First harvest	600 - 800

PETIOLE NO_3^--N SUFFICIENCY LEVELS FOR POTATOES (SOURCE: UNIV. WIISCONSIN-MADISON)

Optimum range of nitrate-nitrogen concentrations (dry weight and sap basis) in potato petiole at various stages of growth

Growth Stage (days after emergence)	Norkotah, Norland, Atlantic, Kennebec	Shepody, R. Burbank, Snowden	Onaway Superior
dae	**Dry Weight Basis (% NO_3^--N)**		
30	2.5 - 2.8	2.0 - 2.3	2.3 - 2.5
40	2.3 - 2.5	1.7 - 2.2	2.0 - 2.3
50	1.8 - 2.3	1.2 - 1.6	1.5 - 1.9
60	1.3 - 1.9	0.8 - 1.1	0.9 - 1.2
70	0.8 - 1.1	0.5 - 0.8	0.4 - 0.6
	Sap Basis (ppm NO_3^--N)		
30	1900 - 2100	1600 - 1800	1800 - 1900
40	1800 - 2000	1600 - 1700	1600 - 1800
50	1400 - 1800	1000 - 1300	1200 - 1500
60	1110 - 1500	700 - 900	500 - 1000
70	700 - 900	500 - 700	400 - 600

Values from the LAQUA can be converted to dry tissue calibration by using the equation:

$$\%\text{Dry Weight } NO_3^-\text{-N} = 0.00142 \text{ (ppm sap } NO_3^-\text{-N)} - 0.21$$

PETIOLE NO_3^--N SUFFICIENCY LEVELS RUSSET BURBANK POTATOES (SOURCE: UNIV. OF MINNESOTA)

Growth Stage	Petiole NO_3^--N (ppm) Dry Tissue	Fresh Sap
Early Vegetative/tuberization	17,000 - 22,000	1300 - 1600
Mid tuber growth/bulking	11,000 - 15,000	900 - 1600
Late tuber growth/maturation	6,000 - 8,000	550 - 700

PETIOLE NO_3^--N SUFFICIENCY LEVELS
(SOURCE: MICHIGAN STATE UNIVERSITY)

The following guidelines are based on one year's research results and will be revised as necessary based on future research findings. Readings taken on youngest fully extended petiole.

Carrots

	Adequate petiole sap nitrate concentration	
Carrot shoulder diameter (in.)	Nitrate-N (ppm)	Nitrate (ppm)
Prior to sizing	750+	3,300+
0.00 - 0.25	550+	2,420+
0.25 - 0.50	450+	1,980+
0.50 - 0.75	300+	1,320+
0.75 - 1.50	250+	1,100+
> 1.50	200+	880+

Celery

	Adequate petiole sap nitrate concentration	
Weeks after transplant	Nitrate-N (ppm)	Nitrate (ppm)
0 - 5	800+	3,520+
5 - 6	725+	3,190+
6 - 7	650+	2,860+
7 - 8	575+	2,530+
8 - 9	500+	2,200+
9 - 10	425+	1,870+
10 - 11	350+	1,540+
11+	275+	1,210+

Onions

	Adequate petiole sap nitrate concentration	
Growth Stage	Nitrate-N (ppm)	Nitrate (ppm)
Up to 5 leaves	800+	2,520+
5 to leaves	600+	2,640+
Bulb initiation	300+	1,320+
Bulb bulking	250+	1,110+

Pre-Sidedress Nitrate (PSNT) Soil Test Interpretation

University of Tennessee

<17	ppm NO_3^--N Low
17 - 25	ppm NO_3^--N Low
>25	ppm NO_3^--N Low

Rutgers Cooperative Extension

PSNT Soil Test Level (ppm NO_3^--N)	**Sidedress N Recommendation**
1 - 15	160
16 - 20	120
21 - 25	80
26 - 30	40
31+	0

University of Wisconsin

	Soil Potential*	
	Very High/High	Medium/Low
PSNT result (ppm N)	**N/application Rate (lbs/Acre)**	
<10	160	120
11 - 12	150	80
13 - 14	125	80
15 - 17	100	40
18 - 20	60	40
>21	0	0

* *consult WMEX pub. A2809*

Pennsylvania Nitrogen Soil Test Recommendation (Lbs N/Acre)
(Source: Penn State University)

Soil Test Level	**Corn Yield Goal**				
(ppm NO_3^--N)	100	125	150	175	200
0 - 10	100	130	160	190	220
11 - 15	75	100	125	150	150
16 - 20	50	75	100	125	125
21 - 25	25	50	75	100	100
25+	0	0	0	0	0

Note: Check you county extension office for updates

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