Plant Sap Testing for Nitrogen and Potassium Status of Vegetable Crops

Application Note

01-2020

Plant sap testing can help growers achieve the optimum fertilization of vegetable crops. Analyzing fresh plant petiole sap for N and K concentrations using LAQUAtwin nitrate and potassium pocket meters is a quick procedure to determine the N and K levels in plants. The results can be used in guiding N and K applications.

Introduction

Soil and plant tissue testing is a valuable tool for determining the fertilizer needs and maximizing the fertilizer efficiency. Soil test is especially useful early in the growing season when plants are too small to collect tissue samples. Plant tissue test for nitrogen (N) and potassium (K) levels during the growing season provides information for diagnosing problems. It is preferred than soil test as the results of which can change quickly by rain or irrigation.

Plant sap testing offers advantages over the conventional dry tissue testing being carried out in laboratories. Aside from the lower cost it requires, plant sap testing can be easily done in the field and the results can be obtained quickly which is important in making fertilization decisions.

Vegetable growers, consultants, and fertilizer companies can use the LAQUAtwin NO3-11 or NO3-11C nitrate pocket meters and LAQUAtwin K-11 potassium pocket meter in the field to help manage N and K fertilizer. These meters are waterproof and equipped with built-in thermistor that detects the sample temperature and replaceable sensor with flat membrane that accepts as little as 0.3 ml sample (0.05 ml with sampling sheet B). They can measure plant sap in just a few seconds and display ion concentration reading expressed in either mg/L or ppm unit. The LAQUAtwin NO3-11 and NO3-11C nitrate pocket meters can measure nitrate ion (NO_3^-) and nitrate-nitrogen (NO_3-N).

Method

Meter Calibration

Prior to sample measurement, calibrate the meters using the standard solutions included in their kits or prepare two standard solutions having concentrations that are ten-fold apart.

Samples should be read within the calibrated range of the meters. Readings outside the calibrated range should be considered inaccurate. Dilute the sap with deionized or distilled water if the reading is above the calibrated range and take the dilution factor into account when calculating the original sap concentration.

1. Select the desired unit in the settings of each meter.
2. Calibrate the meters using their respective standard solutions according to the instruction manuals.

- If LAQUAtwin NO3-11 is set in nitrate-nitrogen (NO_3-N) mode, the readings of 150ppm and 2000ppm nitrate standard solutions will be calibrated as 34ppm and 450ppm NO_3-N, respectively.
- If LAQUAtwin NO3-11C is set in nitrate-nitrogen (NO_3-N) mode, the readings of 300ppm and 5000ppm nitrate standard solutions will be calibrated as 68ppm and 1100ppm NO_3-N, respectively.

When the LAQUAtwin pocket meters are used in the field, it is recommended that they are operated under a shade and recalibrated frequently throughout the day as they are sensitive to temperature changes. It is best to collect petioles from the field and analyze them with the meters indoor. Refer to Technical Tip: LAQUAtwin Ion Sensor Maintenance Procedures for conditioning, cleaning, and storing the meters.

Sample Collection and Preparation

The nitrate level in plant can vary throughout the day. To obtain consistent test results, reasonable standardization of time, temperature, and weather conditions under which sampling is carried out will help.

1. Collect the petioles (leaf stems) of about 20 most-recently-matured leaves—those leaves that have reached maximum size and have changed from a juvenile light green color to a dark green color. Refer to Figure 1 to help you identify petioles of some vegetable crops. There are exceptions however—for example, the roots of onions are used to determine the nitrate levels. Refer to Application Note: Rapid In-Field Determination of Nitrogen in Onions.

Continued at the back

Continued from the front

- Take the leaves from different plants to ensure that the sap sample is representative of the field or the area being tested.
- Petioles may be stored at room temperature (70°F, 21.1°C) in a plastic bag for up to 2 hours. There are longer storage options that do not produce appreciable changes in sap N or K concentrations according to studies conducted in Florida—fresh, whole (unchopped) petioles can be placed in a plastic bag and stored on ice in a cooler for up to 8 hours or frozen overnight. Cold petioles must be warmed to room temperature before crushing so that the temperature differences between sap and meter do not affect the results.

2. Chop and mix the petioles. Take a subsample of chopped petioles for crushing.
3. Squeeze the sap from petioles using a garlic press, lemon press, or hydraulic sap press.
4. Measure the fresh sap using the LAQUAtwin pocket meters within 1-2 minutes of pressing.
5. Record the readings.

Table 2: Guidelines for fresh petiole sap nitrate-nitrogen

Crop	Crop Development Stage	Fresh Petiole Sap NO_3-N (ppm)
Broccoli	Mid growth Button formation Preharvest	1000 - 1600 800 - 1200 600 - 1000
Cabbage[1]	Cupping Early heading Mid heading	1200 - 1500 1000 - 1200 700 - 900
Cantaloupe	Early flower Fruit bulking First harvest	1000 - 1200 800 - 1000 700 - 800
Cauliflower	Mid growth Curd development Preharvest	1000 - 1600 700 - 1000 500 - 800
Celery	Mid growth Preharvest	600 - 800 400 - 600
Lettuce	Early head formation Preharvest	400 - 600 350 - 500
Onion[2]	Bulbs 0.5 - 1.5 inches	350 - 500
Pepper	Vegetative growth Early flower/fruit Fruit bulking Preharvest	900 - 1200 700 - 1000 700 - 1000 700 - 900
Sweet Corn	Entire season	600 - 700
Tomato	Vegetative growth Early flower/fruit Fruit bulking Preharvest	700 - 900 600 - 800 500 - 700 400 - 600
Watermelon	Early flower Fruit bulking First harvest	900 - 1100 700 - 900 500 - 700

1 - Based on one year of data
2 - Long-day type of onions

Source: California Department Food of Food and Agriculture - Guide to Nitrogen Quick-Tests for Vegetables with the Cardy Nitrate Meter

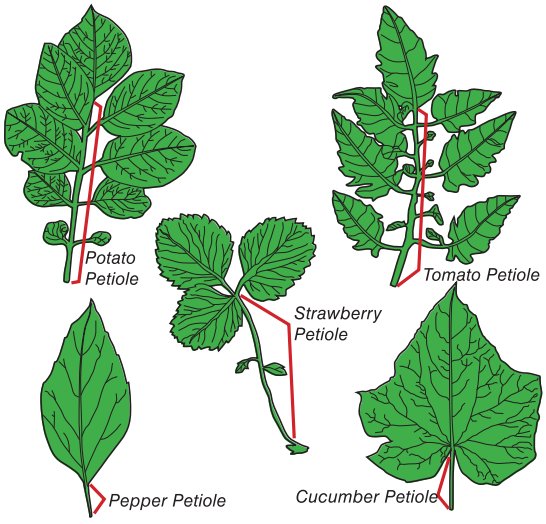

Figure 1: Leaves and petioles of some vegetable crops
Source: University of Florida - Plant Petiole Sap-Testing for Vegetable Crops

Results and Benefits

Over the growing season, vegetable crops differ widely in their nutrient needs and patterns of uptake. With regular plant sap testing and good record keeping, the trend of N and K concentrations can be followed over the season to gain insight on the nitrogen and potassium dynamics of the crop.

It is important to note the plant growth stage at sampling to know what sufficiency standard to apply. There are guidelines for various crops at various growth stages developed and published by universities and research institutes based on their research and field experience. Tables 1 and 2 contain ranges that are suggested critical values.

Table 1. Guidelines for plant leaf petiole fresh sap nitrate-nitrogen- and potassium-testing

Crop	Crop Developmental Stage	Fresh Petiole SapConcentration (ppm)	
		NO_3-N	K
Broccoli and Collard	Six-leaf stage	800–1000	NR[z]
	One week prior to first harvest	500–800	
	First harvest	300–500	
Cucumber	First blossom	800–1000	NR
	Fruits three-inches long	600–800	
	First harvest	400–600	
Eggplant	First fruit (two-inches long)	1200–1600	4500–5000
	First harvest	1000–1200	4000–5000
	Mid harvest	800–1000	3500–4000
MuskmelonF	irst blossom1	100–1200	NR
	Fruit two-inches long	800–1000	
	First harvest	700–800	
Pepper	First flower buds	1400–1600	3200–3500
	First open flowers	1400–1600	3000–3200
	Fruits half-grown	1200–1400	3000–3200
	First harvest	800–1000	2400–3000
	Second Harvest	500–800	2000–2400
Potato	Plants eight-inches tall	1200–1400	4500–5000
	First open flowers	1000–1400	4500–5000
	50% flowers open	1000–1200	4000–4500
	100% flowers open	900–1200	3500–4000
	Tops falling over	600–900	2500–3000
Squash	First blossom	900–1000	NR
	First harvest	800–900	
Strawberry	November	800–900	3000–3500
	December	600–800	3000–3500
	January	600–800	2500–3000
	February	300–500	2000–2500
	March	200–500	1800–2500
	April	200–500	1500–2000
Tomato (Field)F	irst buds	1000–1200	3500–4000
	First open flowers	600–800	3500–4000
	Fruits one-inch diameter	400–600	3000–3500
	Fruits two-inch diameter	400–600	3000–3500
	First harvest	300–400	2500–3000
	Second harvest	200–400	2000–2500
Tomato (Greenhouse)	Transplant to second fruit cluster1	000–1200	4500–5000
	Second cluster to fifth fruit cluster	800–1000	4000–5000
	Harvest season (Dec.-June)	700–900	3500–4000
Watermelon	Vines 6-inches in length1	200–1500	4000–5000
	Fruits 2-inches in length1	000–1200	4000–5000
	Fruits one-half mature	800–1000	3500–4000
	At first harvest	600–800	3000–3500

[z]NR-No recommended ranges have been developed

Source: University of Florida - Plant Petiole Sap-Testing for Vegetable Crops

References and Suggested Readings

1. University of Florida - Plant Petiole Sap-Testing for Vegetable Crops by George Hochmuth. Retrieved from https://bit.ly/2YLIfuz
2. California Department Food of Food and Agriculture - Guide to Nitrogen Quick-Tests for Vegetables with the Cardy Nitrate Meter by Kurt Schulbach, Richard Smith, Tim Hartz, and Louise Jackson. Retrieved from https://bit.ly/3dce0AG

Revision 0, 14 May 2020

HORIBA Instruments (Singapore) Pte. Ltd.
83 Science Park Drive, #02-02A, The Curie, Singapore 118258
Phone: 65 6908-9660
Fax: 65 6745-8155
www.horiba-laqua.com
e-mail: laqua@horiba.com

HORIBA UK Limited
Kyoto Close, Moulton Park, Northampton NN3 6FL
Phone: 44 (0) 1604 542567
Fax: 44 (0) 1604 542699
www.horiba.com/uk
e-mail: waterquality@horiba.com

HORIBA Instruments Incorporated
9755 Research Drive, Irvine, California 92618 USA
Phone : +1 949 250 4811
FAX : +1 949 250 0924
www.horiba.com/us/en
e-mail: labinfo@horiba.com

www.horiba-laqua.com