UF IFAS Extension
UNIVERSITY of FLORIDA

CIR1144
https://doi.org/10.32473/edis-cv004-2022

Plant Petiole Sap-Testing for Vegetable Crops[1]

George Hochmuth and Robert Hochmuth[2]

Various nitrate and potassium "quick-test" kits for vegetable plant sap-testing have been calibrated for use on Florida vegetables. The objective has been to find a system that growers can use in the field to help manage nitrogen (N) and potassium (K) fertilizer—especially for drip-irrigated vegetables.

Testing the plant rather than the soil during the season is preferred because, as the end repository for N and K, the plant provides information for diagnosing problems. N and K are good candidate nutrients for petiole-sap tests because these two nutrients are required in large amounts and often the two main nutrients used in fertigation events. In addition, N and K are mobile in Florida's sandy soils. A soil test for these nutrients provides only a snapshot of the nutrient content of the soil, the results of which can be changed quickly by rain or irrigation.

As growers and consultants begin to use sap test technology, questions arise regarding sap-testing procedures. The following guidelines should help individuals who are currently using—or are interested in using—sap-testing. Most of these guidelines have been developed through research in Florida or are based on Florida field experience. Plant sap quick-test kits measure nitrate-nitrogen, not total N.

Calculations

Nitrate conversions

Some kits read out in nitrates and some in nitrate-nitrogen. Most calibration tables are in nitrate-nitrogen values. For kits that read out in nitrates (NO_3), the reading must be divided by 4.43 to find the nitrate-nitrogen value, which can then be compared to chart values. Potassium is usually read directly as ppm K^+.

Sap vs. dried petioles

There are some published book values for petiole nitrate-nitrogen, but these values are sometimes based on dried petioles and are not directly transformable to fresh sap nitrate-nitrogen concentrations. Only fresh petiole sap nutrient values can be used with a fresh petiole sap-testing procedure.

Sampling

Time of day

Temperature and time of day might influence plant sap nitrate content. Making readings consistently between 9 a.m. and 4 p.m. will yield the most consistent results. Reasonable standardization of temperature and weather conditions under which sampling is carried out will help provide for more consistent and reliable test results.

Leaf age

The Florida calibration charts for vegetable sap-testing were developed for only petioles (leaf stems) of most-recently-matured leaves (MRML)—those leaves that have reached maximum size (essentially stopped expanding in size). MRML leaves also have changed from a juvenile light-green color to a dark-green color.

Leaf part

Tests were calibrated using the fleshy petiole of the leaf (Figure 1). In most crops, the petiole is easy to identify. For tomatoes, which have compound leaves, the petiole is the whole leaf stem with all the small petiolules (and tiny leaflets) stripped off. In normal situations the tomato leaf petiole will be about 8 inches long. Pepper leaf petioles are only about one inch long.

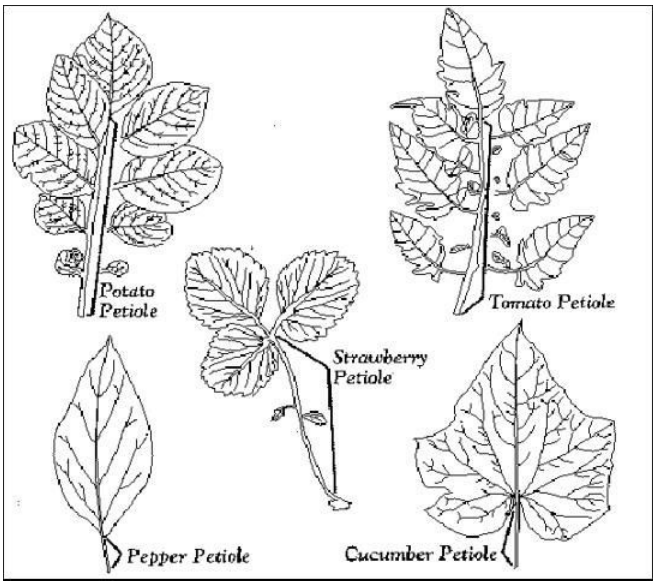

Figure 1. Identification of the petiole in various crops.

Number of leaves

Although three or four petioles may produce a sufficient amount of sap for testing, additional plants must be sampled to ensure that the sap sample is representative of the field or area being tested. Usually about 20 leaves are enough to adequately represent a 5- to 10-acre field if that field is judged to be uniform. Petioles should be immediately removed from the leaf blades to reduce water loss from the petioles through the leaf blades. The petioles should be chopped and mixed, and a subsample of the chopped petiole pieces used for the final sample to crush.

Sap-Testing

Equipment

A garlic or lemon press is used to squeeze the sap from the petiole pieces. If many samples are being tested, a hydraulic sap press is useful. A press also is useful for petioles that have little sap, e.g., strawberry or pepper. Other utensils include a sampling knife, scissors, paper towels, distilled water, chopping knife and board, and the testing kits. There are separate testing kits for N and K.

Storing petioles

Studies have been conducted in Florida that tested options for storing petiole samples to determine flexibility of the testing methodologies for those wishing to sample several farms before making the sap tests. Fresh, whole (unchopped) petioles can be stored on ice for up to 8 hours or frozen overnight without appreciable changes in sap N or K concentrations. The leaf blades should be stripped from the petioles and the petioles placed in a plastic bag on ice in a cooler.

Petioles may be stored at room temperature (70°F) in a plastic bag for up to 2 hours. If whole leaves or petioles are stored in open air, the petioles will wilt, and nutrient readings will not be accurate. Only petioles should be stored—not sap. Cold petioles must be warmed to room temperature before crushing, so that temperature differences between sap and meter do not affect results.

Reading time frame

Measurement of the pressed sap nutrient content must be made within one or two minutes of pressing. Otherwise, nitrate readings could change from the fresh petiole condition when the sap is exposed to air.

Test Kit Management

Test kits should be calibrated and tested with standard, known nitrate and K solutions available from the test kit manufacturer. With colorimetric test kits, calibration with known solutions will reveal if chemicals are still good. Chemicals on test strips or in powder pillows will deteriorate with time and through exposure to heat and light.

Electrode testing kits will need to be calibrated frequently with standard solutions. The calibration should be checked every five or six samples. Readings should be made in the shade or in a laboratory because direct sunlight on the meter can affect its operation.

For the MQuant strip test (available from lab supply sources, like VWR, Fisher, or MilliporeSigma) (Figure 2), a test strip is removed from the container (keep strips cool when not in use) and dipped for a second into the diluted sap. Following 60 seconds, the pink or purple color developed on the test pad on the end of the strip is compared to the calibrated color chart provided with the kit. Interpolation will be needed for readings between any two color blocks on the chart. An alternative is to use a newly developed strip color reader. This reflectometer provides for more quantitative evaluation of the color on the strip. Readings are made in parts per million (ppm) nitrates, which can be converted into ppm nitrate-N by dividing by 4.43.

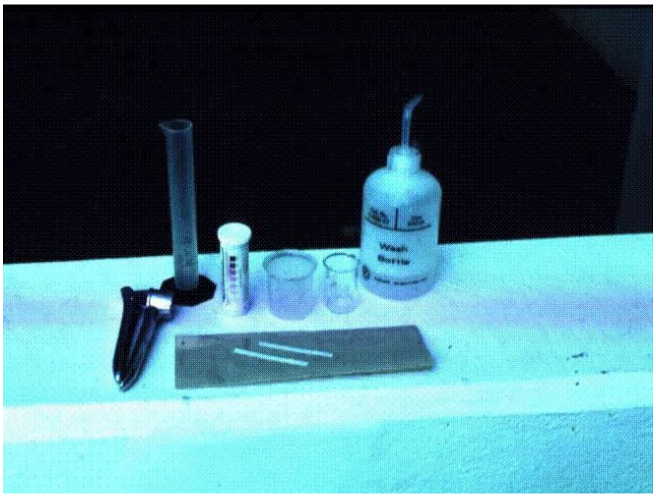

Figure 2. Testing petiole-sap using the MQuant strip test method.

For the HACH colorimeter (https://www.hach.com/nitrogen-nitrate-color-disc-test-kit-model-ni-14/product?id=7640220990), two viewing tubes are filled with diluted sap (Figure 3). One tube is placed in its slot in the "comparator." Contents of one powder reagent pillow are emptied into the second diluted sap sample and the tube mixed for one minute. After mixing, the tube is placed in its slot in the "comparator" and left for one minute. After one minute, the colors in the viewing slots are matched by rotating the color wheel, and the resulting ppm of nitrate-N read from the dial.

Figure 3. Petiole-sap testing using the Hach colorimeter test method.

The colorimetric methods might be influenced by coloration of chlorophylls in the sap. Charcoal filtration of the diluted sap before reading might improve accuracy of measurement of nitrate-N in heavily colored sap.

For the Cardy (Figure 4) or LAQUA (Figure 5) meters (separate meter for N and K analyses), expressed sap is placed on the calibrated electrodes so that a film covers both electrodes continuously. The concentration of nitrates or K is read on the digital scale, which automatically switches among 1x, 10x, or 100x scales for Cardy meters, whereas LAQUA meters provide the actual ppm, depending on concentration of nutrient in sap. Meters should be used and stored in a cool, dry environment. Electrodes can be replaced and are usually good for up to 500 measurements.

Figure 4. Cardy meters for Nitrate-N and K testing with samples.

Figure 5. Horiba LAQUA twin meters for Nitrate-N and K with sample.
Credit: Robert Hochmuth, UF/IFAS

Calibration scale

Samples should always be read within the calibration (reading) scale of the test kit instrument. Readings outside of the calibrated range should be considered inaccurate and may be an indication that the sensor needs replacing. If sample sap nutrient concentrations are higher than the high end of the calibration scale, the sap must be diluted. Dilution can be done with nitrate-free water using about 20 to 50 parts water to 1 part sap.

Kit care

The sap-testing kits are scientific tools requiring careful treatment. The kits and chemicals should be stored in a protected place, within the proper temperature ranges specified by the manufacturer. Kits should not be stored in a pickup truck or at the pump house between uses. If meters are not used for very long periods, it may be advisable to remove the batteries.

Recommendations

Guidelines for petiole sap N and K concentrations are presented in Table 1. Ranges presented are suggested critical values and might need to be refined based on future research or field experience.

Additional Reading

Coltman, R. R. 1987. "Sampling Considerations for Nitrate Quick Tests of Greenhouse-Grown Tomatoes." *J. Amer. Soc. Hort. Sci.* 112:922–927.https://doi.org/10.21273/JASHS.112.6.922

Fletcher, J., R. Hochmuth, and G. Hochmuth. 1993. "Calibration of N and K Fresh Sap Quick-Test Procedures for Polyethylene-Mulched Peppers." *Proc. 24th Natl. Agricultural Plastics Congr.* 24:147–152.

Hochmuth, G., B. Hochmuth, E. Hanlon, and M. Donley. 1991. "Nitrogen Requirements of Mulched Eggplant in Northern Florida." Suwannee Valley AREC Res. Report 91-14.

Hochmuth, G., D. Maynard, C. Vavrina, and E. Hanlon. 1991. "Plant Tissue Analysis and Interpretation for Vegetable Crops in Florida." Fla. Coop. Ext. Serv. Special Series SS-VEC-42.

Hochmuth, G. J., P. R. Gilreath, E. A. Hanlon, G. A. Clark, D. N. Maynard, C. D. Stanley, and D. Z Haman. 1988. "Evaluating Plant N Status with Plant Sap Quick-Test Kits. Proceedings of Tomato Institute." Fla. Coop. Ext. Serv. Spec. Series SS-VEC-801:6–14.

Hochmuth, G. J., B. C. Hochmuth, E. A. Hanlon, and M. E. Donley. 1992. "Effect of Potassium on Yield and Leaf-N and K Concentrations of Eggplant." Suwannee Valley AREC Res. Report 92-2.

Hochmuth, R., S. Rider, D. Fenneman, E. Toro, and N. Parkell. 2015. "On-Farm and Small Plot Research Trials Comparing Petiole Sap Nitrogen and Potassium Concentrations for Seeded vs. Seedless Watermelon Cultivars." UF/IFAS NFREC-Suwannee Valley Research Report.

Hochmuth, R. C., and G. J. Hochmuth. 1991. "Nitrogen Requirements for Mulched Slicing Cucumbers." Suwannee Valley AREC Res. Report 91-18.

Prasad, M., and T. M. Spiers. 1984. "Evaluation of a Rapid Method for Plant Sap Nitrate Analysis." *Commun. Soil Sci. Plant Anal.* 15 (6): 673–679. https://doi.org/10.1080/00103628409367507

Vann, C. D., R. C. Hochmuth, and G. J. Hochmuth. 1993. "Watermelon N and K Petiole Sap Testing." Proc. 1993 Watermelon Institute. Fla. Coop. Ext. Serv. Special Series SS-HOS-003.

Tables

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

Crop	Crop Developmental Stage	Fresh Petiole Sap Concentration (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[z]
	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
Muskmelon	First blossom	1100–1200	NR[z]
	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[z]
	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)	First 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 cluster	1000–1200	4500–5000
	Second cluster to fifth fruit cluster	800–1000	4000–5000
	Harvest season (Dec.–June)	700–900	3500–4000

Crop	Crop Developmental Stage	Fresh Petiole Sap Concentration (ppm)	
		NO_3-N	K
Watermelon—Seeded Cultivars	Vines six inches in length	1200–1500	4000–5000
	Fruits two inches in length	1000–1200	4000–5000
	Fruits one-half mature	800–1000	3500–4000
	At first harvest	600–800	3000–3500
Watermelon—Seedless Cultivars	Vines six inches in length	1200–1500	4000–5000
	Fruits two inches in length	900–1100	4000–5000
	Fruits one-half mature	600–800	3500–4000
	At first harvest	400–600	3000–3500

[z] NR: No recommended ranges have been developed

[1] This document is CIR1144, one of a series of the Department of Horticultural Sciences, UF/IFAS Extension. Supported in part by USDA-ES Smith-Lever 3(d) Water Quality Program Support. Original publication date October 1994. Revised May 2022. Visit the EDIS website at https://edis.ifas.ufl.edu for the currently supported version of this publication.

[2] George J. Hochmuth, professor emeritus, UF/IFAS Department of Soil, Water, and Ecosystem Sciences; Robert C. Hochmuth, regional specialized Extension agent IV—northeast, UF/IFAS North Florida Research and Education Center—Suwannee Valley, Live Oak, FL; UF/IFAS Extension, Gainesville, FL 32611.