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Petiole Sap Analysis - A Ouick Tissue Test for Nitrogen in Potatoes

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Potato growers have reliably used petiole nitrate (NO_3) testing for years as a means of monitoring the nitrogen (N) status of their crop during the growing season. This is a particularly effective technique in potato production, since the petiole is a very sensitive indicator of current soil N supply, and management practices such as supplemental N application through irrigation systems (fertigation) allow for corrective measures when deficiencies or excesses are detected.

The chief limitation to petiole testing is the amount of time required to dry samples, send them to a commercial lab for analysis, and then receive the results. This takes at least several days, and more typically a week or more. The problem is that,- while petiole $N0_3$ analysis gives the grower information about current soil N availability, the information may be received after-the-fact. The development of a quick method for analysis in the field or on-site would greatly improve the application of tissue testing. The grower or consultant could combine immediate 'information from analysis with observations in the field to make decisions about adjustments to fertigation programs.

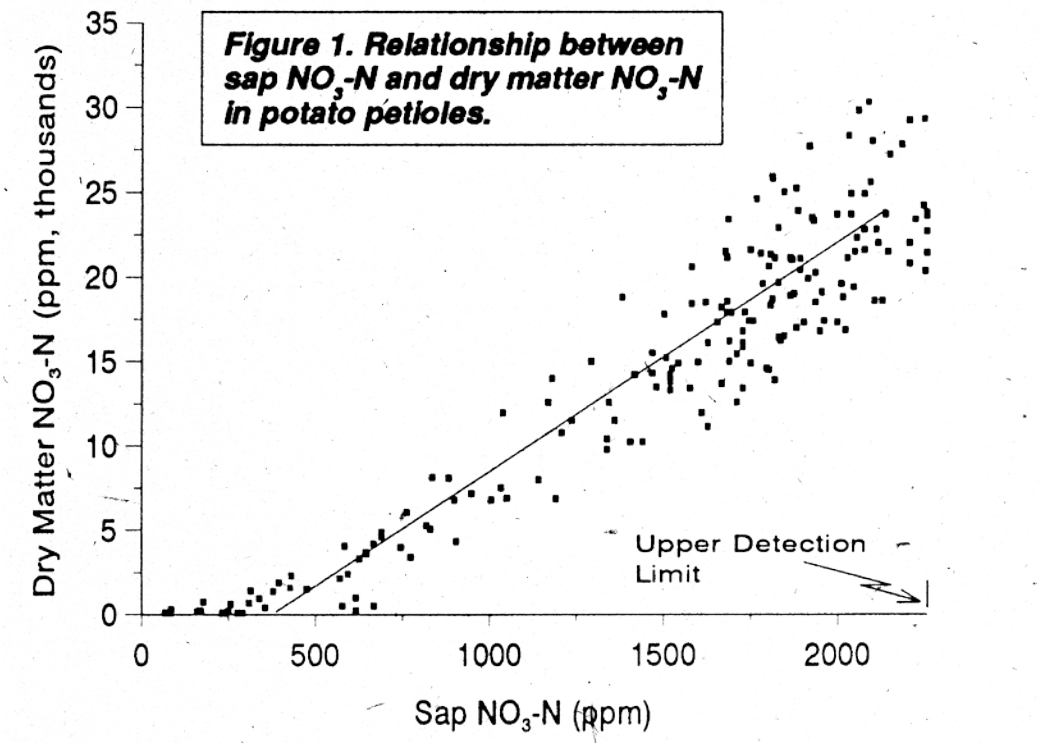
Petiole sap analysis for $N0_3$ concentration is proposed as a quicktest method to provide immediate information about crop N status. Instruments are commercially available that can be used to directly measure $N0_3$ concentration in relatively small quantities of liquid and that do not require a laboratory setting for accurate calibration and use. One such instrument is the Cardy ($N0_3$ meter *(no endorsement of this product is intended, nor is criticism implied of similar products not mentioned)* which is pocket-size, currently costs about $300, and is simple to use. A sample size normally collected for petiole testing with conventional methods will yield more than sufficient sap to obtain a reading with this type of meter. Sap extraction and analysis can be completed in the field.

The development of a new plant diagnostic technique requires the identification of critical nutrient levels (below which a yield reduction occurs) in the specific plant tissue and with the specific analytical method being proposed. This is usually done by establishing the relationship between crop yield and measured tissue nutrient levels. In the case of conventional petiole testing, critical nutrient levels in dry petiole tissue have been well established in virtually all potato growing areas. It would be a time-consuming, costly process to perform the same amount of work in calibrating a new technique such as petiole sap analysis. However, development of a sap quicktest would be fairly simple if there is a good relationship between petiole sap NO_3 concentration and petiole dry matter NO_3 concentration. Such a relationship would allow the simple conversion of established critical values for petiole dry matter NO to critical values for petiole sap NO_3.

The research reported here establishes this relationship and provides critical values for petiole sap NO_3 analysis. Russet Burbank potatoes were grown in 1990 and 1991 on a Creston silty loam at the Northwestern Agricultural Research Center in Kalispell in a replicated field trial with irrigation amounts and N fertilizer timings as treatments, thereby establishing a wide range in crop water and N status for comparison of the two analytical procedures. Petiole samples were collected from four specified irrigation levels in each of the N treatment plots on a weekly or biweekly basis beginning in early July through the remainder of the growing season. A total of 80 samples, 30 to 40 petioles per sample, was collected on each of the five or six sampling dates each year.

The sap from 15 to 20 petioles in each sample was extracted and analyze for NO_3 concentration using the Cardy NO_3 meter. The remaining petioles were dried and saved for later analysis for dry matter NO_3 concentration according to the conventional protocol for petiole testing. Results were compared between the two methods.

There was a consistent relationship between sap NO_3-N concentration and dry matter NO_3-N concentration in potatoes across both years of testing (Figure 1). The only problem encountered was the upper detection limit of the Cady meter which is 10,000 ppm NO_3 or 2,258 ppm NO_3-N. Sap NO_3 at this level corresponds to dry matter levels of about 20,000 ppm NO_3-N. The result was a loss of accuracy in the higher readings early in the growing season. This problem may be overcome by calibrating the meter on a NO_3-N basis instead of a NO_3 basis, as was employed in this research.



With petiole dry matter NO_3-N levels ranging up to 20,000 ppm, as typically found during the tuber bulking period, the relationship between sap NO_3 -N and dry matter NO_3-N is:

Sap $N0_3$-N = (.085 x Dry Matter NO_3-N) + 322, using units of ppm.

This equation can be used to convert existing petiole NO_3 criteria to use in sap analysis. Conversely, it may be desired to convert sap readings to dry matter readings for comparison. in that case:

Dry Matter NO_3-N = (11.8 x Sap NO_3-N) - 3,800, again using ppm.

A conversion chart (Table.1) is included to make this process more convenient, with established criteria noted. The potato petiole sap quicktest method for NO_3 concentration using a portable NO_3 meter is ready for field application using the conversion equations or table included here. The meter is fairly simple to use, but several words of advice in using this new method am warranted:

1. All units reported here are on a ppm NO_3-N basis. If the standards used in calibration are expressed on a NO_3 basis, then meter readings can be converted to a NO_3-N basis by multiplying by 0.226.
2. If calibrated on a NO_3 basis, the upper detection limit of the meter will limit its use to the period after tuber initiation.

3. The sample to be analyzed. should be representative of the field being tested and the analysis should be carried out as soon as possible after sampling.
4. Petiole sap analysis, like dry matter analysis, is an accurate indication of crop N status, but it is just one of the pieces of information that a grower uses to manage a fertilization program.

Table 1. Conversion chart for relating potato petiole sap NO_3-N values to petiole dry matter NO_3-N values, or vice versa. This chart allows the critical values for petiole NO_3-N previously established on a dry matter basis to be applied to the now petiole sap anaIysis quicktest.

Petiole Dry Matter NO_3-N	**Petiole Sap NO_3-N**
ppm	
25,000[1]	2,445[1]
20,000	2,020
18,000	1,850
15,000[2]	1,600[2]
13,000[2]	1,425[2]
10,000	1,170

1Critical level at tuber initiation.

2Citical levels during tuber bulking.

FertiIizer Facts

- Sap analysis is a new, approach to petiole testing for N management in potatoes.
- Portable NO_3 meters can be used on-site to analyze petiole sap for NO_3 content, providing immediate information about crop N status to the grower or consultant.
- Established critical values for potato petiole dry matter NO_3 management can be applied to sap analysis by simple conversion.

Edited by Jeff-Jacobsen, Extension Soil Scientist