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Chasing Petioles

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Introduction

Many growers, especially those who fertigate, track petiole and soil nutrient levels across the season. The sampling frequency varies, but once per week is typical. The underlying goal is to provide actively growing plants nutrients as they need them. A common industry term for these on-demand nutrient applications is ‘spoon-feeding.’ Soil values are tracked to provide insight into nutrient soil reserves while the petioles provide an indication of plant health relative to nutrient status and growth stage. Literature indicating proper soil and petiole values for the major nutrients (N, P, K) exists for many potato growing regions. The values were likely established following several years of research with one or more common varieties.

Petiole analysis can provide meaningful data; however, nutrient values can be skewed by deficit or excessive irrigation, growth compromising issues like disease, insect feeding, herbicide sensitivity, and non-typical growth due to abnormal weather conditions. Moreover, the petiole analysis is only as good as the sample collected and the size of that sample. To properly understand the data from petiole analysis, one needs to take into account petiole sample size and quality, soil nutrient status, growing degree days/heat units and their effect on plant growth, plant growth stage, potential nutrient release from slow-release fertilizers or decomposing organic matter, and plant health. Because so many factors affect petiole nutrient status, interpreting the data may be more of an art than a science.

Of all fertilizers, Nitrogen (N), typically urea ammonium nitrate (UAN, Solution-32), is fertigated in the largest quantities. Plant growth responds very well to in-season N applications and this is often demonstrated through petiole nitrate analysis. During years with “typical” growing conditions (typical = lacking temperature and moisture extremes at abnormal times), maintaining recommended petiole values is easier than during non-typical years, especially if conditions in the non-typical years are such that plants grow extremely fast upon emergence. Rapid foliar growth leads to high demand for nutrients, especially nitrogen. If your soil N is inadequate for rapid foliar growth, your petiole nitrate values may decline rapidly. Under these conditions, multiple N applications through the irrigation system may not bring the petioles back within the recommended ranges for several weeks, if at all during the season.

Will you see reduced yield and economic return if you don’t keep your petioles within the recommended ranges? Not necessarily. We’ve seen some of the best potato yields during the non-typical years when petioles did not behave.

Ten Years of Nitrogen Research across Eighteen Potato Varieties

Across 10 years (2007-16), we tested eighteen potato varieties under four full season nitrogen rates, typically 150-, 250-, 350-, and 450-lbs N/acre. Approximately 75- to 125-lbs N/acre was available in the soil prior to planting (soil residual + pre-plant urea broadcast). The remaining N (UAN, Soln 32) was applied once to twice weekly at rates between 0- and 40-lbs/A via a flood sprayer (overhead irrigation fertigation simulator) between tuber initiation (early June, 50-60 days after planting) and the mid to late tuber bulk (late July, 100-110 DAP) (Table 1). Petiole and soil samples were collected weekly or bi-weekly between June and early August. The crop was allowed to grow between 150- and 180-DAP prior to harvest. Following harvest, tubers were separated into typical U.S. yield and cull grades and internal and external quality was evaluated. N fertilizer cost-adjusted gross return was calculated for either the fresh (baked potato) or process (French fry) market.

Each year, the experimental N rates were applied blindly without regard for petiole values. Petioles were tracked to proof the N rates, they were not used to drive the applications. The goal was to provide the plants with N weekly to twice weekly within a reasonable growth window. Application rates varied from 10 to 40 lbs/A (Table 1). During rapid foliage growth (after tuber initiation and up to peak canopy growth (approx. 95 to 110 days after planting) most of the N was applied for each rate, however, the in-season total for each rate was split into 8-9 applications, tapering off near the end of July/first of August (Table 1). The exception was the lowest rates. They may have only received N during the first two to four applications, or upon satisfying the predetermined quantity.

Table 1. In-season and full-season nitrogen rates and application intervals for each experimental rate (150-, 250-, 350-, and 450-lbs/A N). The application intervals and in-season quantities shown here are typical of the strategy used across 10 years of N research on eighteen potato varieties at the WSU-Othello Research Center located in central WA.

	21 DAE	+ 7 days	+ 6 days	+ 4 days	+ 6 days	+ 7 days	+ 7 days	+ 7 days	+ 7 days		
	10-12 inch Plant Height									In-Season	Full-Season
Treatmt Rate	9 Jun	16 Jun	22 Jun	26 Jun	2 Jul	9 Jul	16 Jul	22 Jul	31 Jul	N Rates	N Rates
					lbs/A						
150	20	10	0	0	0	0	0	0	0	30	150
250	25	25	20	20	20	10	10	0	0	130	250
350	30	30	25	25	25	25	25	25	25	230	350
450	40	40	40	40	40	35	35	30	30	330	450

120 lbs/A pre-plant + soil residual N, All other nutrients non-limiting and applied pre-plant
-Used solution 32-0-0, Urea Ammonium Nitrate
-Each treatment was applied using 0.10 inches of water

Lessons Learned

Even though nitrogen rates and application timings were similar each year, petiole nutrient levels never tracked the same. Petiole nitrate values fluctuated yearly, weekly, and across varieties; however, the differences among the four nitrogen rates were clear during most years. Clearwater Russet petiole nitrates are shown as an example of rate differences and yearly and weekly fluctuations (Figure 1).

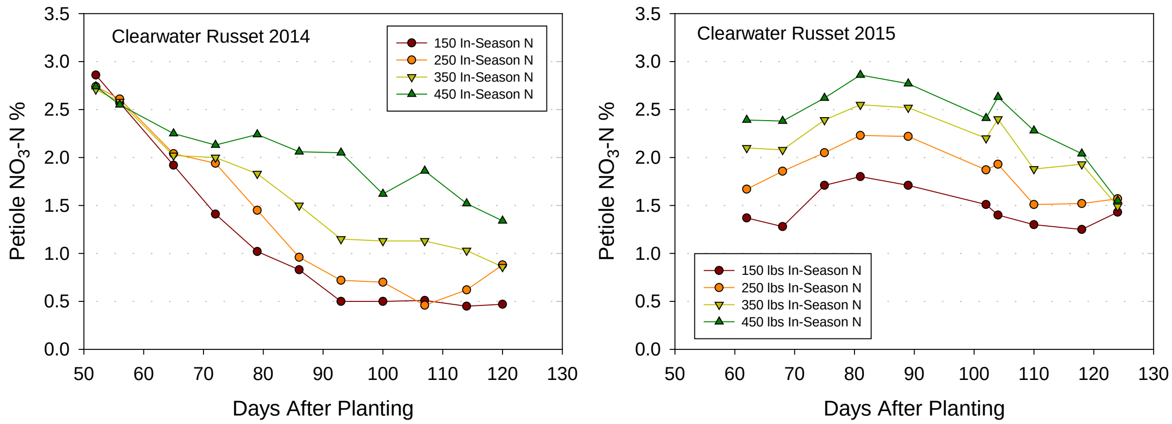


Figure 1. Clearwater Russet petiole nitrate values across time during 2014-15 for four full-season nitrogen rate treatments (150-, 250-, 350-, and 450-lbs/A N).

During several rapid early-growth years (especially 2016), the petiole nitrate values dropped well below what one might consider "acceptable," even with regular N applications and full-season rates of up to 450 lbs/A. As an example, Clearwater Russet petiole nitrate values from the 2016 350 lbs/A treatment are shown in Figure 2 along with the recommended petiole N range (Figure 2). Despite relatively low petiole nitrate values during rapid early-growth years, economic return was as good as, and often better than, those found in the more typical production years. Clearwater petiole nitrate levels during 2016 were up to 60% below the recommended values (Figure 2), however, the total yield for Clearwater Russet in 2016 was 40% higher than the average yield of the 2014-15 seasons. Petiole values for the 350 lbs/A rate were much closer to the recommended values during the 2014-15 seasons.

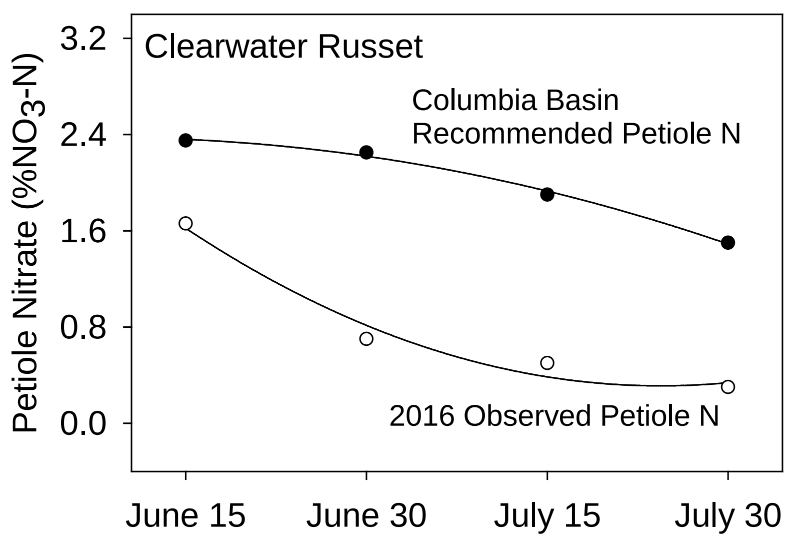


Figure 2. During 2016, petiole nitrate values declined rapidly (2016 Observed Petiole N) due to rapid plant growth during non-typically warm weather in May and June, even though N was applied once or twice weekly (Table 1). The 2016 observed petiole N is from the 350 lbs/A treatment. Total yield in 2016 was 40% greater than the yield average from 2014-15, even though petioles from 2014-15 were closer to the recommended nitrate range than those from 2016.

Ten years of research also revealed that over 90% of the time the nitrogen rate required to maximize tuber yield was greater than that used to maximum economic yield. Alturas is shown as an example in Figure 3.

Twenty nine percent of the 18 varieties tested produced maximum economic returns with less than 350 lbs/A of N, 53% used between 350- and 400-lbs/A, and 23% used more than 400 lbs/A. Averaged across all varieties, the maximum tuber yield required 399 lbs/A of N while the maximum economic yield was realized with 348 lbs/A of N. The maximum economic yield was achieved with 51 lbs/A less N, or 15% less, than was required to maximize tuber yield.

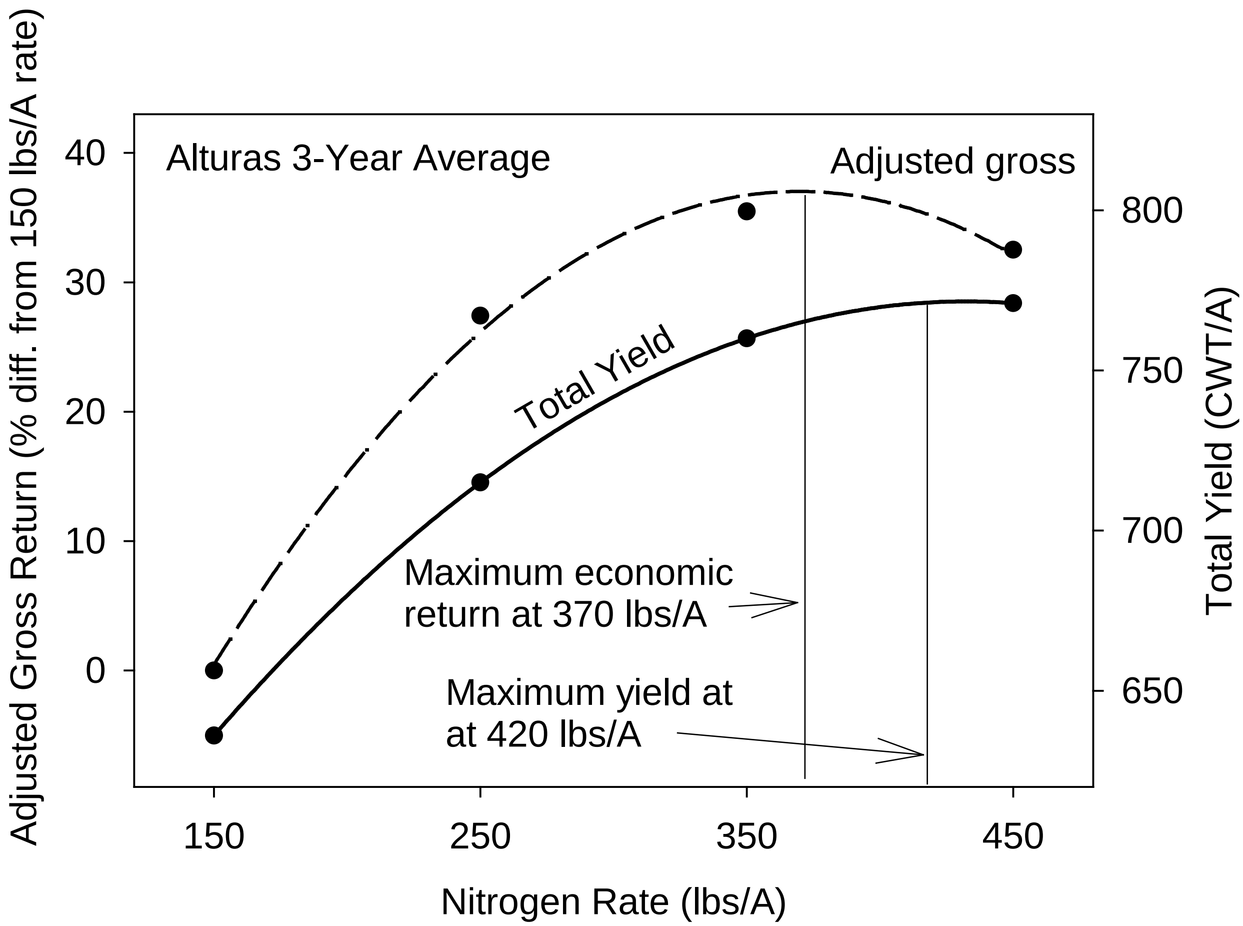


Figure 3. Alturas fertilizer cost-adjusted gross return and total yield averaged across 3 years. Maximum economic return was realized with 370 lbs/A N while maximum yield required another 50 lbs of N. Ninety percent of the time across ten years of research and eighteen potato varieties the maximum economic return was realized with less nitrogen than the maximum total yield.

Summary

The ultimate goal of all producers should be to produce the yield that maximizes grower return, or the economic yield. All too often, the goal is to produce the maximum yield for the given situation. Because sufficient economic return is key for businesses to remain competitive and maintain production, one must consider “the law of diminishing returns.” At some point, higher yields from additional inputs (more fert, protectants, etc.) become too expensive to achieve. The potential economic gain in yield increase from each additional input is eventually offset by the cost of those inputs. In other words, when one maximizes yield, they are not always maximizing economic return.

Following pre-plant soil nutrient analysis, fertilizer target rates should be established for the variety, expected days of growth, and soil type. **Petiole values alone should not drive in-season nutrient applications.** They should be used as a guide in combination with target rates and soil nutrient levels. We’ve learned that when petiole values appear unfavorable, the best strategy is to maintain your targeted applications and apply the season total fertilizer you initially intended.

We recommend applying pre-plant or at-planting nitrogen so there is 75- to 150-lbs/A of available N (soil residual + applied) in the root zone at emergence. Weekly or twice-weekly applications of nitrogen from tuber initiation through mid-bulk (June and July/early August in the Columbia Basin, see Table 1) will most likely keep the plants happy and healthy, even if the petiole nitrate values are lower than recommended.

From our research, we compiled recommended nitrogen target rates along with petiole nitrate values for different calendar dates (Table 2). Columbia Basin growers should strive to hit the season total N targets listed. Growers in shorter growing seasons should adjust accordingly. Petiole and soil samples should be collected prior to row closure and continue through the season until late bulking (once every 2 weeks is adequate). Soil N should be at or below 50 lbs/A by mid-August and plants kept healthy via "spoon-feeding" of nitrogen. With low soil N and the cessation of N applications prior to mid-August, plants will be able to adequately mature during August and September.

For nutrient recommendations other than N, growers should follow the nutrient management guidelines established for Russet Burbank:

> Lang N.S., R.G. Stevens, R.E. Thornton, W.L. Pan and S. Victory. 1999. Nutrient management guide: Central Washington irrigated potatoes. WSU Experiment Station Extension Bulletin EB1882.

Table 2. Full-season nitrogen target rates for 150-180 days of growth in the Columbia Basin of Washington and Oregon along with target petiole rates during June and July. Growers should strive to have 75- to 150-lbs/A of nitrogen in the soil (residual + applied) at emergence and apply the remainder during the season via irrigation (fertigation). To ensure plant maturity, stop nitrogen applications prior to mid-August.

Variety	Full Season Nitrogen Target Rate	Petiole Nitrate Target Concentrations			
		June 15	June 30	July 15	July 30
Process Market Recommendations	lbs/A	-----------------% NO_3-N------------------			
Alpine Russet	370	2.9	2.3	2.0	1.7
Alturas	370	2.6	3.0	2.2	1.5
Classic Russet	360	2.7	2.5	2.3	2.0
Clearwater Russet	375	2.4	2.3	1.9	1.5
Mountain Gem Russet	340	2.6	2.3	2.0	1.8
Owyhee Russet	325	2.8	2.5	2.1	1.7
Payette Russet	425	2.5	2.8	2.2	1.6
Ranger Russet	360	2.8	2.6	2.4	2.3
Russet Burbank	350	2.6	2.2	2.0	1.7
Sage Russet	375	3.1	2.8	2.6	2.4
Teton Russet	350	2.7	2.5	2.2	2.0
Umatilla Russet	400	3.0	2.8	2.5	2.1
Fresh Market Recommendations					
Classic Russet	330	2.7	2.3	2.0	1.8
Mountain Gem Russet	300	2.6	2.1	1.8	1.6
Teton Russet	325	2.7	2.3	2.0	1.8

Potato Tuberworm

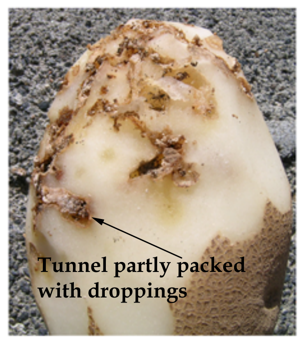
See also: http://www.nwpotatoresearch.com/

Foliar Damage

Larvae live in the leaves and stems during the growing season

Tuber Damage

Tubers exposed at surface are most likely infested



This tuber had 5 large larvae

Tuberworm life stages

Eggs

Mature larva ~1/2 inch long

Larva in tunnel

Cocoon on potato

Idaho Potato Commission (Phone: 208-334-2350)