



Nutrient Recommendations for Russet Burbank Potatoes in Southern Alberta

Precise fertilizer application rates are critical for optimal potato production. Sufficient nutrients are needed to maximize tuber yield, quality and uniformity. However, too much fertilizer means unnecessary costs for the producer and potential harm to the environment.

Potato petiole (stalk between leaf and stem) sample analysis has been used to monitor the nutrient status of potato crops throughout the growing season. This technique can be useful and timely for monitoring any mid-season crop deficiencies, ones that were not identified in spring soil samples.

The current recommended petiole nutrient (NO₃-N, P and K) concentrations used in Alberta have come from research conducted in the northwest United States, where longer growing seasons and different soil conditions and climate prevail. Petiole analysis results from previous Russet Burbank studies in southern Alberta have shown that the current recommendations based on USA research may need fine tuning to suit southern Alberta growing conditions.

This concern led to a project to determine optimal petiole nutrient recommendations for Russet Burbank potatoes grown in southern Alberta. The analysis focused on the rates of nitrate nitrogen (NO₃-N), phosphorus (P) and potassium (K). As this factsheet explains, optimal petiole nutrient concentration ranges for southern Alberta have been developed based on this research.

The research

Experimental design

Ten rates of N, P and K fertilizers were surface-applied in April 2004, 2005 and 2007 to strips in a small portion of fields of grower-managed Russet Burbank potatoes in southern Alberta. The 10 treatments consisted of four increasing rates each of N, P and K fertilizer while the other nutrients were held constant.

In 2004 and 2005, each treatment plot was 8 rows wide (24 ft) and 115 ft long. In 2007, each treatment plot was 6 rows wide (18 ft) and 115 ft long. All plots ran adjacent to a pivot road. There were a total of four randomized replications of the experiment.

Petiole sampling

Petiole samples were collected and analyzed for each plot on seven dates in each of the three years of the study, beginning in late June and finishing in late August. The fourth leaf stem (petiole) from the top of the main stem was taken, and leaflets were removed in the field (see Figure 1).

Nutrients are needed to maximize tuber yield, quality and uniformity.

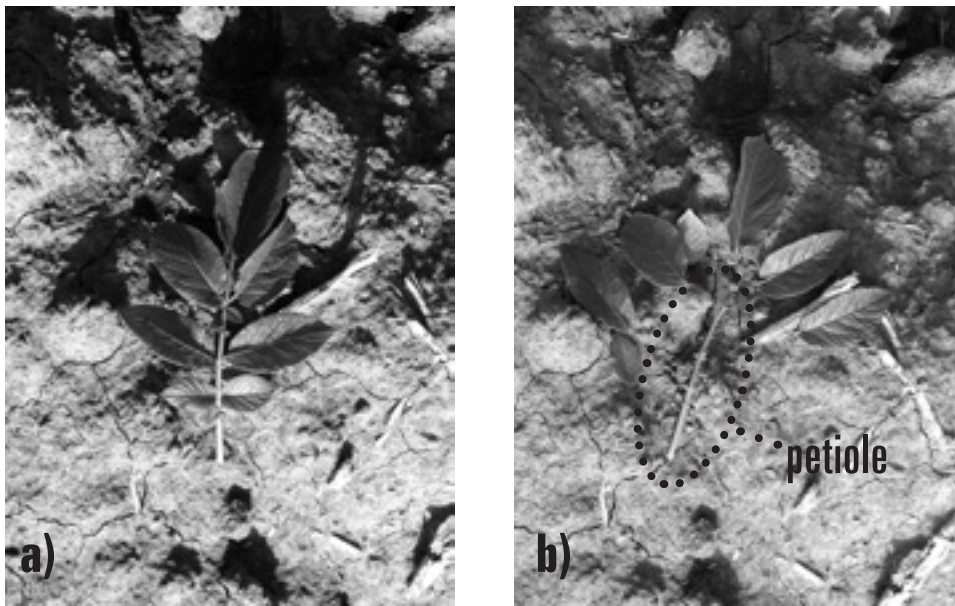


Figure 1. Russet Burbank fourth leaf stem a) before and b) after removal of leaves (petiole shown in dashed circle).

Approximately 80 petioles were collected from each plot, at each sampling date. Staff were instructed to sample representative plants only and to avoid any unhealthy or overly advanced plants.

Petiole samples were collected between 8 a.m. and 11 a.m. and were kept in a cooler and then air-dried overnight (at 45-50°C). Samples were ground and sent to a laboratory for analysis of the nitrate nitrogen ($\text{NO}_3\text{-N}$), phosphorus (P) and potassium (K).

Tuber harvest

Tuber samples (2 x 25 ft strips) were collected in mid- to late September using a two-row harvester. In the laboratory, samples were washed, graded and weighed to calculate total yield, marketable yield, mean tuber weight and per cent smalls. Grading categories used were small (<1 $\frac{7}{8}$ in), medium (1 $\frac{7}{8}$ – 3 $\frac{1}{2}$ in), over-size (> 3 $\frac{1}{2}$ in) and deformed. Marketable yield was defined as total yield minus yield of small tubers.

Specific gravity was calculated with the weight in air divided by weight in water method on 25 medium tubers for each sample.

Critical petiole nutrient concentrations

To determine the optimal petiole nutrient concentrations, a curve was fitted to the yield versus petiole nutrient relationship, and the petiole concentration at the maximum yield value for the curve was called the 100% relative yield petiole concentration (100%RY).

The maximum yield was multiplied by 0.9 to calculate the 90% relative yield. The corresponding petiole nutrient concentration (90%RY) was calculated for each petiole sampling date.

The petiole nutrient concentrations at 100% and 90% relative yields were plotted as a function of the days after planting (DAP) for each corresponding sampling date (Figure 2). These plots indicate the optimal ranges for petiole nutrients throughout the growing season, with the 100%RY representing the upper limit of the range and the 90%RY representing the lower limit.

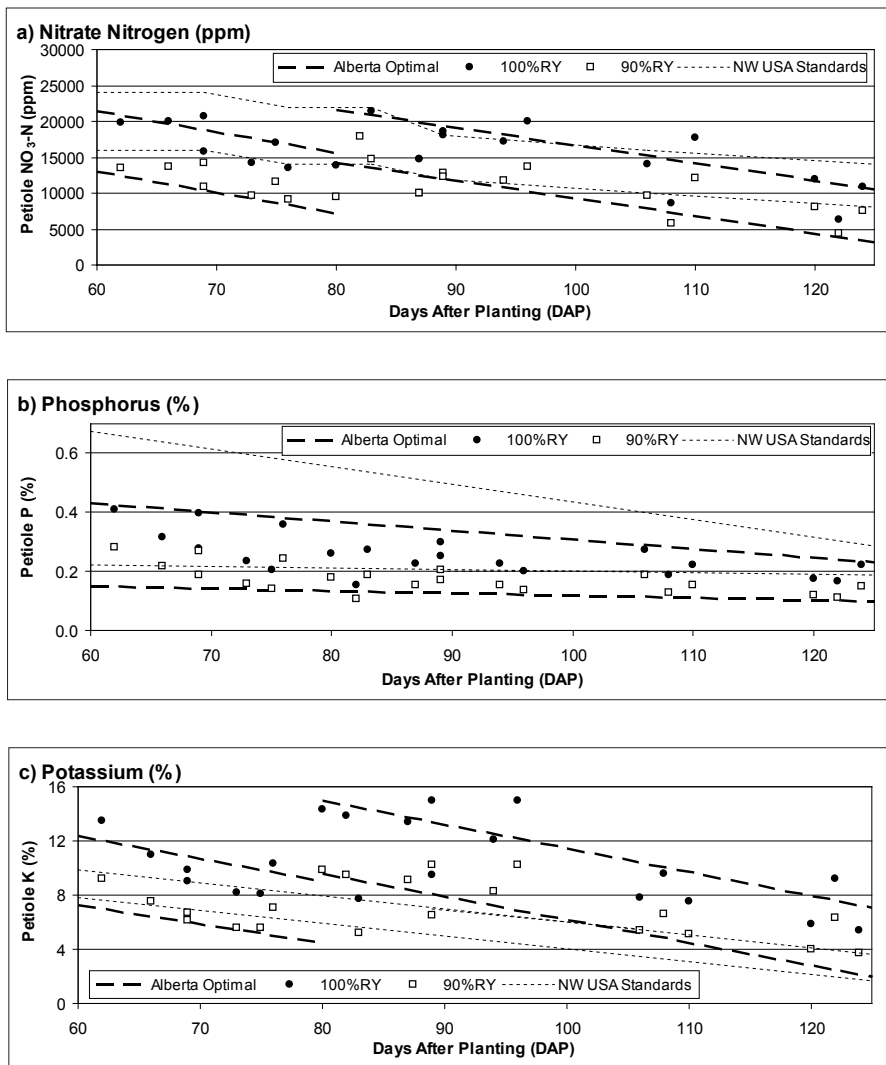


Figure 2. Suggested Russet Burbank petiole nutrient (NO_3-N , P and K) concentration recommendations.

Based on information from southern Alberta (Alberta Optimal), experimental data and current petiole nutrient concentration recommendations, which are based on information from the northwest United States (NW USA Standards).

The results

The values of 100%RY and 90%RY were compared to days after planting (DAP) for all three years combined to determine optimal petiole nutrient concentrations specific for southern Alberta (Figure 2).

It is important to remember that these upper and lower limits are for optimal yield (90-100% of relative yield) of Russet Burbank potatoes and are merely guidelines (Table 1). Actual petiole nutrient concentrations will be

affected by genotype, climate, irrigation amount, soil type, planting date, petiole sample collection technique and laboratory analysis.

Table 1. Suggested optimal Russet Burbank petiole nutrient (NO₃-N, P, and K) contents based on information from southern Alberta (2004, 2005 and 2007)

Days after planting (DAP)	Optimal petiole nutrient concentrations					
	NO ₃ -N (ppm)		P (%)		K (%)	
	90%RY	100%RY	90%RY	100%RY	90%RY	100%RY
60	13000	21400	0.15	0.43	7.3	12.4
65	11550	19950	0.15	0.41	6.6	11.6
70	10100	18500	0.14	0.40	5.9	10.7
75	8650	17050	0.14	0.38	5.2	9.9
80	7200	15600	0.13	0.37	4.5	9
85	12978	20378	0.13	0.35	8.8	14.1
90	11756	19156	0.13	0.34	7.9	13.2
95	10533	17933	0.12	0.32	7.1	12.4
100	9311	16711	0.12	0.31	6.2	11.5
105	8089	15489	0.12	0.29	5.4	10.6
110	6867	14267	0.11	0.28	4.5	9.7
115	5644	13044	0.11	0.26	3.7	8.9
120	4422	11822	0.10	0.25	2.8	8
125	3200	10600	0.10	0.23	2.0	7.1

Nitrate Nitrogen (NO₃-N)

The suggested optimal petiole NO₃-N concentrations are quite similar to the current NW USA standards, especially for greater than 80 DAP. It is suggested that there should be two sets of ranges, one set for prior to and including approximately 80 DAP and another set for after approximately 80 DAP.

Phosphorus (P)

The suggested optimal petiole P concentrations are substantially lower than the current NW USA standards, particularly early in the growing season.

Potassium (K)

The suggested optimal petiole K concentrations have a wider range than the current NW USA standards. Similar to NO₃-N, it is suggested that there be two sets of ranges of petiole K concentrations, one set for prior to approximately 80 DAP and another set for after approximately 80 DAP.

Effects of Climate

Although it was not a part of the initial objectives of the project, the effects of climate were examined using data from previously completed Potato Growers of Alberta-sponsored studies done between 1997 and 2001 and using data from this study (2004, 2005 and 2007).

In years when June and July are hotter than average, petiole NO₃-N concentrations may be greater than usual at the start of the measuring dates and may decrease at a greater rate than in cooler years. This result may be due to the plant growing faster in hotter June-July weather and being unable to sustain sufficient rates of nitrogen uptake, or it may be an artefact of heat stress.

The potential effects of climate reinforce the notion that petiole nutrient recommendations should be treated as guidelines only that will be affected by climate, soil and other environmental factors, as well as by human factors.

The conclusions

New optimal petiole nutrient concentration ranges for optimal marketable yield have been developed specific to Russet Burbank potatoes grown in southern Alberta's soil and climatic conditions (shown in Table 1). These proposed optimal petiole nutrient concentrations were compared to data collected in previously completed studies and were found to be valid.

Nitrogen – The suggested petiole nitrate nitrogen range is slightly lower than the northwest USA standards at the beginning of the growing season (DAP < 80) and late in the growing season (DAP > 105).

Phosphorus – The revised optimal petiole phosphorus ranges are substantially lower than the northwest USA standards.

Potassium – The recommended petiole potassium ranges are wider than the northwest USA standards overall and are similar early in the growing season (DAP < 80). Later in the growing season, the upper limits of the new petiole potassium recommendations are greater than for the northwest USA standards.

Producers and agronomists can use these petiole nutrient recommendations along with their petiole sample laboratory results to make decisions about in-season fertilizer requirements. The new suggested optimal ranges should be considered as guidelines only and should be viewed in the context of previous years' data from any given site.

Petiole nutrient concentrations will be affected by many factors in addition to available soil nutrients. Some of these factors include temperature, precipitation, soil texture and other environmental factors, as well as human factors such as petiole sampling technique, irrigation management, location of samples within the field and laboratory analysis.

Petiole nutrient concentrations should be considered on a field-specific basis. Spatial variability exists across any field, so care must be taken to choose petioles from benchmark locations that are representative of the field, in terms of location and plant appearance.

The conclusions drawn in this study are based on three years of experimental data (2004, 2005 and 2007), and it is suggested that the Potato Growers of Alberta, along with

growers and processors, continue to refine these recommendations based on the petiole nutrient concentrations they observe currently and in the future.

Acknowledgements

This project was made possible with the financial support of the Potato Growers of Alberta (PGA) and Alberta Agriculture and Rural Development. The PGA also provided equipment, manpower and expertise to assist with the tuber harvest. McCain Foods provided funding to allow an additional petiole sampling to be added each year of the study. Sandberg Laboratories Ltd. provided a discounted analysis rate. Jerry Zeinstra, Greg Nakamura and Tony Bos are kindly acknowledged for hosting the trials.

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Petiole nutrient recommendations are affected by climate, soil, environmental and human factors, so should be used as guidelines only.

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