Potato Nutrient Use and Management Tips across Varieties

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Introduction

Time, and time again, research has demonstrated that the addition of fertilizer to nutrient deficient soils is beneficial for crop growth and production. Application rates and petiole and soil sufficiency ranges for nitrogen (N), phosphorus (P), and potassium (K), and some micronutrients like sulfur, zinc, boron, and magnesium have been established for most crops in most primary production regions. The difficulty for commercial crop producers is determining proper nutrient input levels when production or plant growth conditions are non-typical. The difficulty is compounded as one ponders whether growing conditions are really ever "typical".

Prior to making important production decisions, growers should remember a few concepts. One has to do with yield potential – what is the actual attainable yield, given the land, potato variety, environmental limitations, etc.? Yield can be put into several categories:

- Potential Yield
  - no restrictions except genetics, absolute maximum
- Attainable Yield
  - maximum yield grower can attain in a given situation
- Economic Yield
  - yield that maximizes grower return
- Actual Yield
  - actual yield a grower attains in a given situation
- Primitive Yield
  - no inputs used, environment not manipulated

The ultimate goal of all producers should be to produce the yield that maximizes grower return, or the economic yield. All too often, their goal is to produce the maximum yield for the given situation, or the attainable yield. Because sufficient economic return is key for businesses to remain competitive and maintain production, the second concept growers should embrace is "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 years of nitrogen and phosphorus research on many potato varieties and having experienced production years with rather extreme variations in ambient temperatures and heat unit accumulation, we provide recommendations for Columbia Basin potato producers based on previous and ongoing research and economic analyses.

Materials and Methods

Nitrogen Trials
Across 10 years (2007-16), eighteen potato varieties were tested under four full season nitrogen N) 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 35-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). Petiole and soils 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 US yield and cull grades and internal and external quality was evaluated. Nitrogen fertilizer cost-adjusted gross return was calculated for either the fresh (baked potato) or process (french fry) market.

Phosphorus Trials
Across 6 years (2011-16), up to eight potato varieties were tested under three full season phosphorus rates, 0-, 227-, and 454-lbs P/acre. Phosphorus was applied in a variety of manners: all pre-plant broadcast, split applications of 75/25 pre-plant broadcast, banded (liquid and dry), and 100% applied via the irrigation water. Phosphorus sources include 11-52-0 and 10-34-0.

Results and Recommendations

Nitrogen
Ten years of research 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 1. Twenty nine percent of the 18 varieties tested produced maximum economic returns using 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.

We recommend applying pre-plant or at-planting nitrogen so there is 125- to 150-lbs/A of available N (soil residual + applied) in the root zone at emergence. Petiole and soils during the growing season should be used as a guide, however, growers should strive to hit the season total N targets (Table 1). 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-July 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.

Phosphorus
There was typically significant benefit from applying 227 lbs P2O5 on 8 varieties compared to the NO-P control; on rare occasion, 454 lbs P2O5 was also beneficial (Figures 2 and 3). When averaged across years, the 454 lbs/A appeared to be detrimental to economic return (Figure 3). Based on this and other recent research, we recommend Columbia Basin growers have at least 227 lbs of P2O5 (soil available +

applied) available in the soil at or soon after plant emergence. Application of excessive P2O5 (454 lbs or greater) has the potential to reduce grower yield and economic return.

For nutrient recommendations other than N and P, growers should follow the nutrient management guidelines established for Russet Burbank (Lang et al. 1999).

Table 1. Full season nitrogen target rates for the Columbia Basin of Washington and Oregon along with target petiole rates during June and July. Growers should strive to have 125- 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	360	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

Figure 1. Adjusted gross return ($) and total tuber yield for Alturas averaged across three years of research. Note that the Adjusted gross return (economic yield) was maximized with 366 lbs/A of nitrogen, while the tuber yield was maximized with 435 lbs/A of nitrogen.

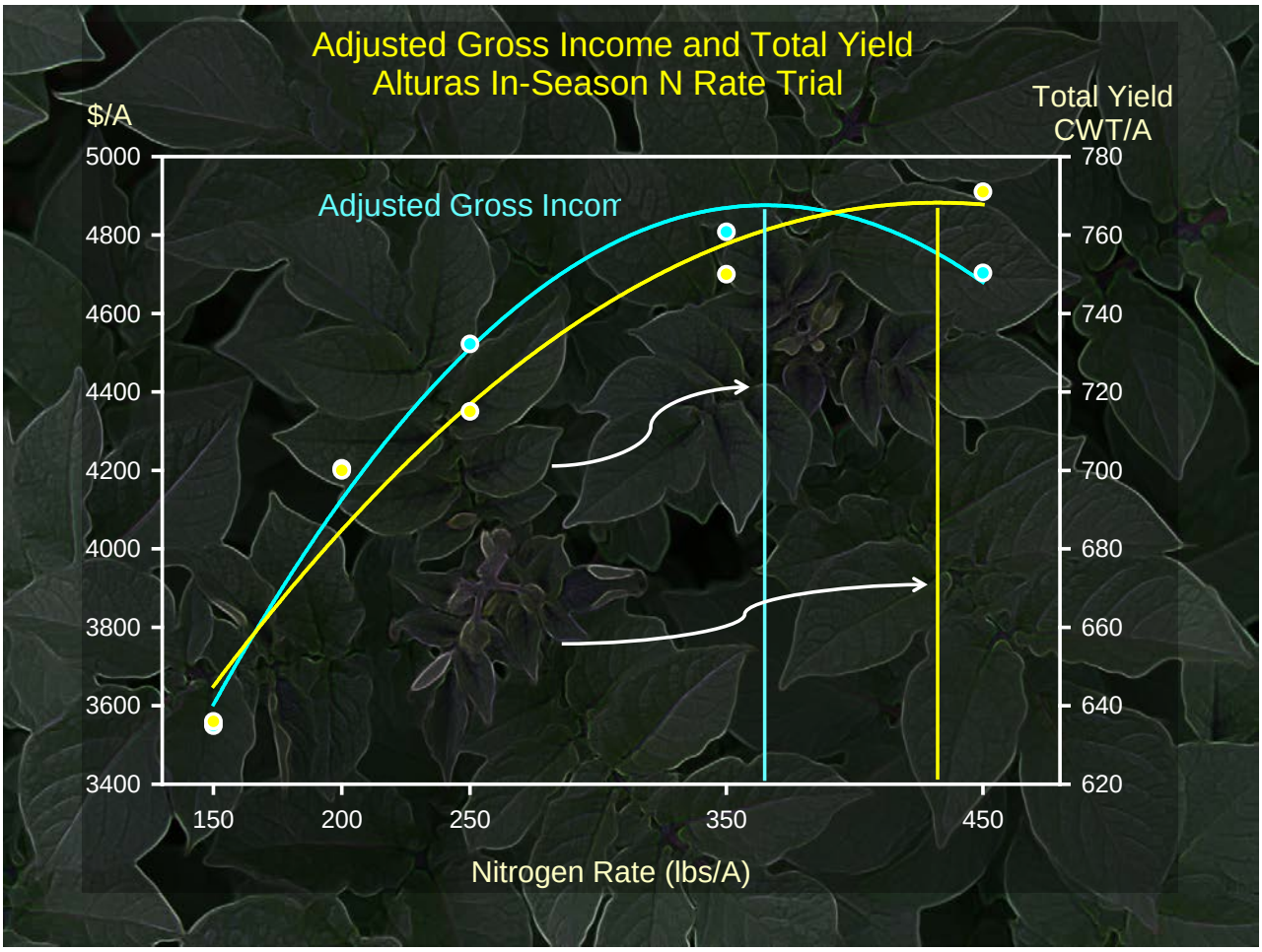

Figure 2. Adjusted gross return ($) for eight potato varieties when 0- or 227 lbs/A phosphorus was added to the soil. Soil ppm of phosphorus was typically between 10 and 14, with pH > 7.0.

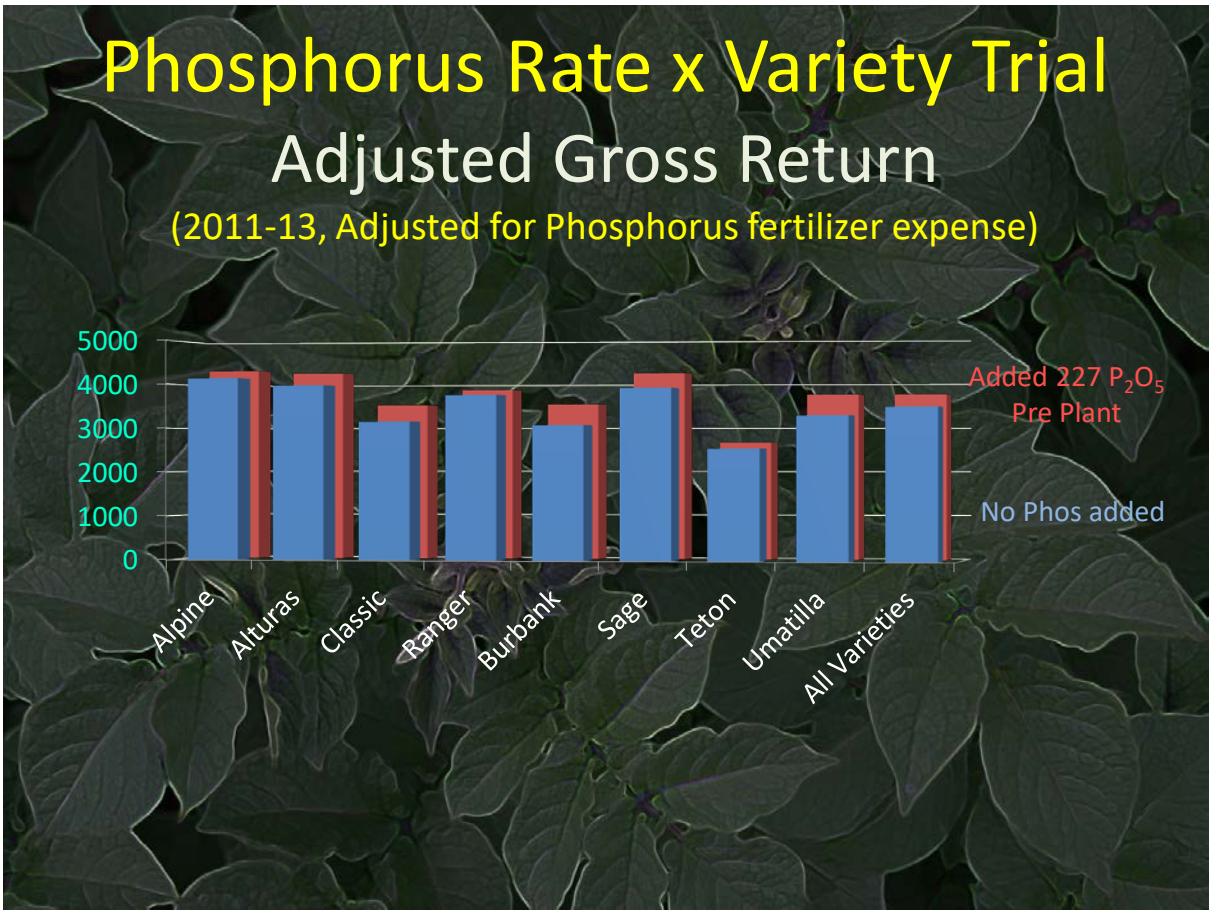

Figure 3. Adjusted gross return, percent difference from the non-treated control NO-P or 0 rate averaged across Russet Burbank, Ranger Russet, and Umatilla Russet and years 2011-13 or 2013 only (single year). Rates were 0- 227- and 454-lbs/A of phosphorus. All P was applied pre-plant broadcast (11-52-0). Soil ppm of phosphorus was typically between 10 and 14, with pH > 7.0