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Sustainable Production of New Potato Varieties

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Background

Many large potato buyers have recently started to survey their potato suppliers to document pesticide use, and this new requirement comes on top of extensive auditing programs like "Good Agricultural Practices" and "Sustainable Agricultural Practices." These programs have been primarily aimed at ensuring food safety; but have recently targeted pesticide use, carbon footprint and environmental impact. Potato producers already strive to optimize applications of inputs, but varieties such as Russet Burbank (RB) are relatively input intensive due to low resistance to disease and environmental stress. One of the best ways to meet consumer demands for more sustainable potato production practices is through adoption of new potato varieties with increased pest and stress resistance. The goal of a recent multi-year research project funded in part by the ISDA specialty crop block grant program and the Idaho Potato Commission was to document the extent to which we can reduce fertilizer, irrigation and pesticide inputs for five newly released potato varieties from the Northwest Potato Variety Development Program (Tri-state).

Fertilizer Use

Research was conducted to determine the potential for reducing N requirements for newly released varieties. Nitrogen responses were evaluated from a series of field trials conducted at the Aberdeen Research & Extension Center. In these trials, the N response of Russet Burbank was compared to Alpine Russet, Alturas, Clearwater Russet, Premier Russet and Umatilla Russet. In each trial, N fertilizer was applied at 0, 90, 180, 270 or 360 lb N/acre to all varieties; 50% was applied prior to planting and 50% during tuber bulking. To compare the N use efficiency (NUE) of the new varieties to Russet Burbank, the total yield produced per lb of N at the point of maximum yield (expressed as cwt/lb N/ a) was determined for each variety (Table 1).

All of the new varieties had appreciably higher NUE values at maximum yield than RB. Improvements in NUE ranged from 70% for Alturas to 16% for Umatilla Russet. The resulting reductions in the N fertilizer requirement ranged from 42% for Alturas to 14% for Umatilla.

Table 1 Nitrogen use efficiency (NUE) and N requirement of five potato varieties compared to Russet Burbank.

Variety	NUE cwt/lb N/a	NUE % of Russet Burbank	Reduction in N Requirement (%)
Alpine Russet	1.77	118%	15%
Alturas	2.84	170%	42%
Clearwater Russet	2.00	133%	25%
Premier Russet	2.33	139%	28%
Umatilla Russet	1.89	116%	14%

The amounts of N fertilizer required for the Tri-State varieties adjusted for yield goal are presented in Table 2. The differences between optimal N fertilizer applications for most of the varieties and Russet Burbank are substantial. For example, for a field with a potential yield of 600 cwt/a, Alturas would require 130 lb N/a less than Russet Burbank or a total of 20,800 lb N for a 160 acre field.

Table 2 N recommendations for 6 potato varieties adjusted for differences in N use efficiency.

Variety	Yield Goal (400 cwt/a)	Yield Goal (500 cwt/a)	Yield Goal (600 cwt/a)
	----------Nitrogen Rate (lb N/a)----------		
Russet Burbank	240	280	320
Alpine Russet	200	235	270
Alturas	140	165	190
Clearwater Russet	180	210	240
Premier Russet	175	200	230
Umatilla Russet	105	240	275

Production of Umatilla Russet, Alturas and Premier Russet in ID, OR, and WA was about 48,000 acres in 2011, potentially reducing the amount of nitrogen applied to the soil by 4.8 million pounds compared with the same acreage planted to the old standard, Russet Burbank. In 2011, the potential economic savings to NW growers was over $3.1 million. The reduced use of nitrogen should also significantly reduce the potential for nitrate-contaminated ground water in the region.

These results show that the potential for improving the efficiency of N fertilizer use through the use of these newer potato varieties is substantial. Reducing fertilizer applications by 20-40% per unit of yield produced would not only provide considerable economic benefit to growers but would also provide environmental benefits and contribute significantly to the sustainability of potato production systems.

Water Use

Russet Burbank, Alpine Russet, Alturas, Clearwater Russet, Premier Russet, and Umatilla Russet were grown at different water application rates at the Aberdeen Research & Extension Center in 2010-2011. Each main plot was irrigated by one of the three irrigation treatments: 100% ET (20 inches) full season, 75% ET (15 in) full season, and 50% ET (10 in) full season. Evaporation was determined by using the modified Penman estimates provided through the AgriMet system. Irrigation timing was identical for each treatment, with only the length of irrigations differing to produce three irrigation rates. The differential irrigation treatments were applied throughout the tuber initiation and bulking stages.

Responses were mostly similar for the two years, so the 2010 data will be used to highlight the key results. All of the newer varieties produced higher US No 1 yields compared to Russet Burbank across the wide range of irrigation levels used in this study (Figure 1). With respect to total yield, Umatilla, Alpine and Premier generally produce the highest yields under severe stress. For US No 1 yields, Clearwater and Premier generally produced the highest yields under severe stress. Of the newer varieties, Alturas exhibited the greatest susceptibility to water stress due primarily to its relatively large

vine and lower proportion of dry matter partitioning to the tubers. All of the newer varieties also had lower percent sugar ends than Russet Burbank (data not shown).

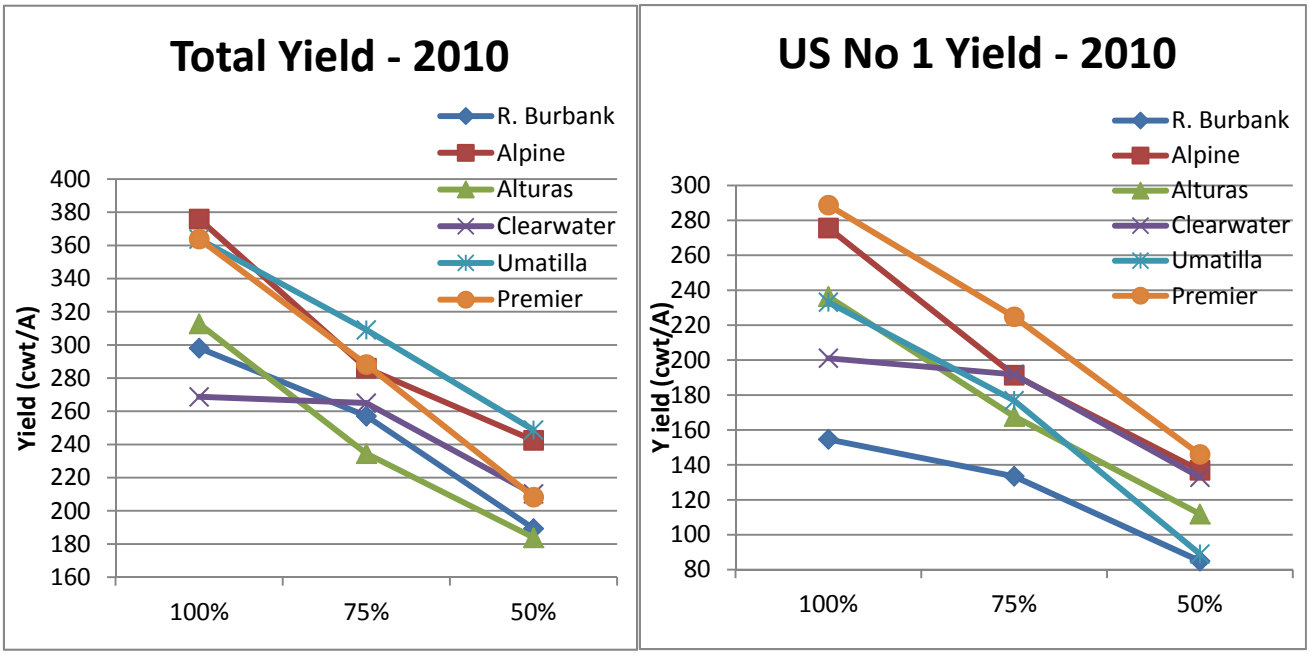

Figure 1. Total and US No 1 yields for 6 potato varieties irrigated at 50, 75 and 100% ET in 2010.

These results show that the potential for improving water use efficiency through production of newer potato varieties is substantial. For example, Alpine, Premier and Umatilla produced approximately 18 cwt in total yield for each inch of applied water in 2010, compared to 15 cwt for Russet Burbank (a 20% improvement). Differences among varieties in the amount of applied water per cwt of US No 1 yield were even greater. Improved water use efficiency would potentially provide an economic benefit to growers in terms of reduced pumping costs, but would also provide protection from major losses in yield and quality in years when snow pack conditions or other factors result in restrictions on water availability for irrigation.

Pesticide Use

Alpine, Alturas, Clearwater, Premier, and Umatilla and Russet Burbank, were planted in field trials at the University of Idaho Research & Extension Centers in Aberdeen and Parma during 2010-2011 to evaluate the interaction between varietal resistance and the number of fungicide applications or fumigant application rates required to provide disease protection. Although we measured the impact of variety and pesticide use on the incidence of a wide range of diseases, the results for early blight were most dramatic and will be highlighted here.

Alturas exhibited the most resistance to early blight at both locations, while Umatilla had the highest level of foliar infection (Figure 2). Russet Burbank was intermediate in disease incidence, but responded the most strongly of all varieties to multiple fungicide applications in terms of total yield (Figure 3). In contrast, Alpine, Alturas and Clearwater showed very little to any yield response to increasing fungicide applications. This suggests that one fungicide treatment is just as effective in preventing disease and obtaining yields as multiple fungicide applications in disease resistant varieties.

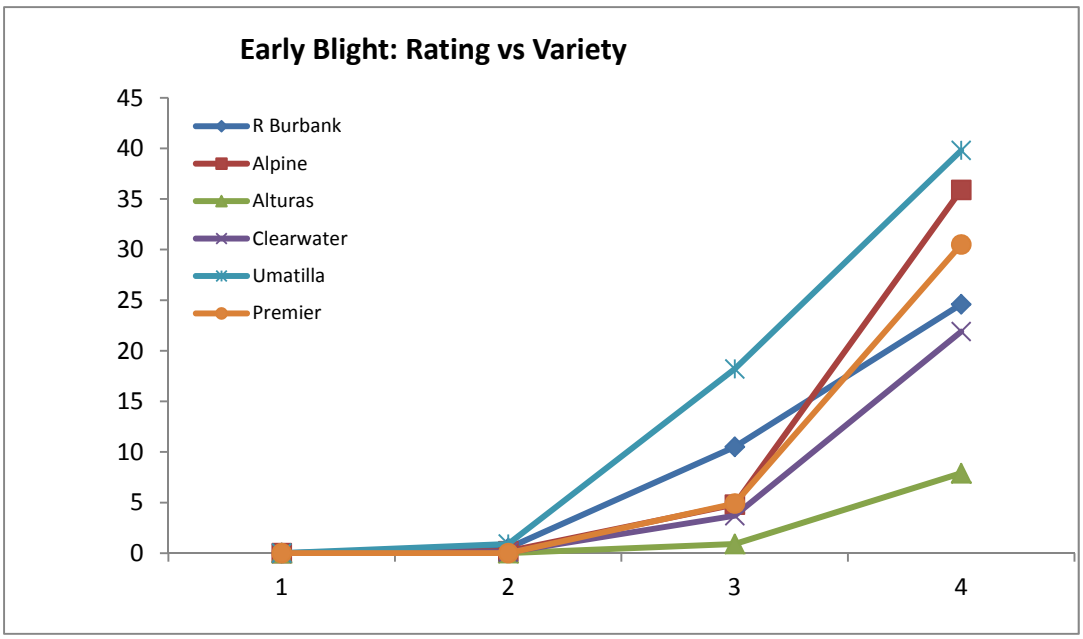

Figure 2. Incidence of foliar early blight infection (% foliage infected) in 6 potato varieties grown at Parma, ID in 2010. Evaluation dates were July 22, Aug6, Aug 20 and Sept 3.

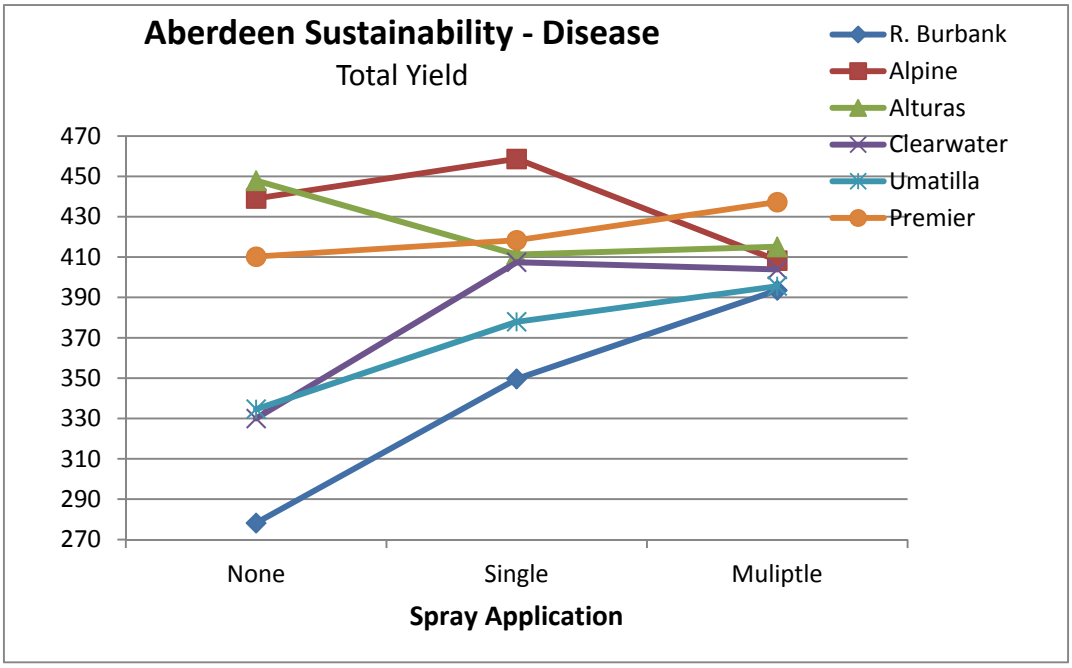

Figure 3: The effect of the number of fungicide spray application on total yields (cwt/ac) of 6 potato varieties grown in 2010 trial at Aberdeen, ID. Values are the means of 3 fungicide applications and 4 replications.

The results from this study show that many new varieties have good levels of resistance to foliar diseases which are commonly found in Idaho. This suggests that growers could achieve significant savings by reducing the number of fungicide applications that they make to their crop in order to control early blight when growing these disease resistant varieties. If growers are worried about controlling other diseases, instead of reducing the number of fungicide applications made they may be able to reduce the fungicide application rate, or use fungicides that target diseases other than early blight.

Project Summary: Columbia Root-Knot Nematode Variability

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Columbia root-knot nematode (CRKN; *Meloidogyne chitwoodi*) is widespread in the Pacific Northwest and is a significant threat to a sustainable potato production in the region. CRKN causes tuber defects, which can make entire shipments unmarketable even if only a relatively low percentage of tubers are affected. CRKN is a quarantine pest, which places restrictions on infested shipments to export markets. Control of CRKN heavily relies on costly chemical control tactics. Breeding efforts to develop resistant potato cultivars are underway but CRKN races that are able to break resistance genes in potato have recently been discovered.

The goal of this study is to survey the variability of CRKN and to develop better tools to identify resistance-breaking CRKN races. This project will benefit the potato industry because it will lead to a better understanding of the disease potential of CRKN and allow for more targeted resistance breeding.

IN ORDER TO CONDUCT THIS STUDY WE NEED YOUR HELP!

- **We need potato tubers that show symptoms of CRKN infection**. Typical symptoms include galls (bumps) on the surface of tubers (Fig. 1) and small brown spots in the flesh close to the skin (Fig. 2).
- **We need to know the location of where these tubers were grown** (at minimum county level, but more detailed information is welcome).
- **We need 10-15 tubers <u>with symptoms</u> per field.**

If you see tubers that show typical nematode symptoms as described above, please contact the project leader. We will cover shipping fees for tubers sent to our lab in Pullman or can arrange for pickup if you set the tubers aside for us. Your participation in this project is greatly appreciated! Shipping address (please contact Axel Elling **prior** to shipping to arrange for free shipping):

Axel Elling
Department of Plant Pathology
Washington State University
100 Dairy Road
201 Johnson Hall
Pullman, WA 99164

Typical symptoms of CRKN infection:

Fig. 1. CRKN symptoms can range from severe growth distortions (left) in tubers from heavily infested fields to tubers with galls and bumps on the surface (right) from fields with low nematode numbers.

Fig. 2. When peeled, infected tubers show small brown spots (left). These spots are always close to the tuber skin (right).