POTATO VARIETAL RESPONSES TO NITROGEN RATE AND TIMING

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ABSTRACT

The cultivar Russet Burbank accounts for the majority of potato acreage planted in Idaho each year. With increasing demands on growers to produce a superior crop with minimal input, there are several new cultivars that are increasing in popularity. With these new cultivars, there has arisen a need to evaluate their specific nitrogen requirements. Applying the current fertilizer regimes used on Russet Burbank to these new varieties may not be maximizing their inputs for production. The discovery of optimal nitrogen rates and application times would help produce a superior crop, while potentially reducing production costs by maximizing fertilizer utilization. This study was undertaken to evaluate different nitrogen levels, applied primarily preseason or primarily in-season, and their effects on yield, grade and internal quality.

INTRODUCTION

Current fertilizer guidelines within the state of Idaho are based on optimum fertility rates and potential yields for Russet Burbank (Stark and Westermann, 2001). As with most crops, potatoes will respond to an increase in available N by maximizing tuber growth and maintaining this growth throughout the growing season (Kleinkopf et al., 1987). However, too much available N can have negative effects on tuber yield and quality. Excess N at or before tuberization can reduce yield and specific gravity of indeterminate varieties such as Russet Burbank. Too much late season N may also delay tuber maturity and subsequently reduce storability and quality. These effects of N availability patterns on tuber growth, yield and quality have lead to recommendations for split N applications, with lower levels applied pre-plant (Stark and Westermann, 2001).

Newer potato cultivars are becoming more widely grown because of improved characteristics such as earliness, improved yield, quality and storability, and increased resistance to insects, pathogens and other environmental stresses. However, little information is available on the nutrient requirements of these newer cultivars. On Prince Edward Island, it was found that Butte, Frontier Russet and Russet Burbank all had a linear response to N applications, while Century Russet, Shepody and Ranger Russet had curvilinear responses. The curvilinear relationship suggests that the effect of N is reduced at the higher rates; while the linear relationship suggests that more N may be added without a loss of efficacy (Arsenault et al., 2001). This study illustrates that the N requirement of Russet Burbank may be different, either higher or lower, than those of the newer cultivars.

Cultivars with tuber growth periods that are longer or shorter than Russet Burbank may also require different patterns of N availability. Shorter season cultivars may set tubers more quickly and therefore require less preseason N to prevent delayed tuber development. Late season N may not need to be applied to these cultivars because they mature earlier, thus reducing the total seasonal N requirement. Finding the optimum N rate may reduce the total N applied

and supply N at the appropriate times within the season, thus optimizing the yield and grade of the crop.

OBJECTIVES

The present study was undertaken to determine optimal N rates and application timings for some of the newer potato cultivars. Determination of these optimum N rates should maximize yield and the quality of the potato crop while improving N use efficiency and minimizing impacts of the environment.

MATERIALS AND METHODS

Experiments designed to determine optimum N rates and application timings for 7 potato cultivars were carried out at two sites, including Aberdeen, ID from 1999 to 2001 and Parma ID, in 2001 and 2002. At Aberdeen, N as NH_4NO_3 (34-0-0) was applied to 4 varieties (Russet Burbank, Gem Russet, Bannock Russet and Summit Russet) at 4 rates (0, 90,180, or 270 lb N/A) using two seasonal N application patterns. Nitrogen was applied either 1) 2/3 pre-plant plus 1/3 in-season (early treatment), or 2) 1/3 pre-plant plus 2/3 in-season (late treatment). At Parma, N as NH_4NO_3 was applied to three varieties (Alturas, Ranger Russet and A8893-1) at five rates (0, 100, 200, 300, or 400 lb N/A, with two seasonal N application patterns. Nitrogen was applied either 1) 1/3 preseason plus 2/3 in-season (during tuber bulking) or 2) 2/3 preseason plus1/3 in-season. All preseason applications were broadcast applied and mechanically incorporated into the soil. All in-season N was hand applied at 1-2 week intervals during tuber bulking and incorporated with ½ to 1 inch of sprinkler irrigation. All plots were irrigated with a solid set sprinkler system, maintaining 65% available soil moisture throughout the growing season.

All experiments were set up as a split block design, with fertilizer rates and timings as main plots and the varieties as sub-plots, with five replications. At the Parma site, the plots were 4 rows wide, set at 36-inch row spacing, and 50 feet long. The Aberdeen plots were 6 rows wide with 36-inch row spacing and 40 feet long. A 10-inch within row seed piece spacing was used at both sites. The soil type at the Parma site is a Greenleaf-Owyhee silt loam, while at the Aberdeen site the soil type is a Declo sandy loam. At both sites the two center rows of the plot were harvested and evaluated.

All plots were evaluated after harvest for yield, grade and internal quality. From the yield and grade data, relative yields were calculated and then run through quadratic regression models comparing relative yield with soil plus fertilizer N for each variety-N timing combination. Maximum yields were also calculated based on the optimal N rates generated by the regression models.

RESULTS AND DISCUSSION

Alturas is a late season variety and produced a maximum yield of 570 cwt/A with the late N treatment at an optimum N rate (soil + fertilizer N) of 233 lbs N/A (Fig. 1). Results with Alturas for the early N treatment were similar with a maximum yield of 564 cwt/A at an optimum N rate of 244 lb N/A. Based on the relative total yields and relative US No.1 yields, a recommendation of 220-260 lbs N/A applied 2/3 pre-plant should maximize production of Alturas. By comparison, current recommendations for similar yields (550-600 cwt/A) of Russet Burbank potatoes would be about 300-320 lbs N/A of soil + fertilizer N (Stark and Westermann, 2001).

Ranger Russet is also a late season variety and produced a maximum yield of 476 cwt/A with the early N treatment at an optimal N rate of 261 lb N/A, and a maximum of 473 cwt/A with the late N treatment at 282 lb N/A (Fig. 2). Based on the relative total yields and relative US No.1 yields, a recommendation of 250-290 lbs N/A with 2/3 applied pre-plant will maximize the production of Ranger Russet. The current guidelines for similar yields of Russet Burbank are 260-280 lbs N per acre, which is similar to that observed for Ranger Russet.

A8893-1 is a relatively early variety and showed the greatest response to N rate and timing. This variety produced a maximum of 466 cwt/A with the late N treatment at an optimum N rate of 243 lb N/A, and a maximum of 453 cwt/A with the early N treatment at 289 lb N/A (Fig. 3). Therefore, a recommendation of 240-280 lbs/A of soil + fertilizer N applied 1/3 pre-plant should maximize the production of A8893-1 within a yield range of 450-500 cwt/A. This recommendation is similar to the current guidelines for Russet Burbank at this yield level.

Nitrogen timing had little effect on either maximum yield or optimum N rate for both Bannock Russet and Gem Russet grown at the Aberdeen location (Figs. 4 and 5). Maximum yields for these two varieties were similar ranging from 341 to 353 cwt/A, while optimum N rates were 188-190 lb N/A for Bannock Russet and 229-235 lb N/A for Gem Russet.

By comparison, maximum yields for Russet Burbank were 336 and 328 cwt/A for the early and late N treatments, respectively (Fig. 6). Russet Burbank used the early-applied N more efficiently than late N with an optimal N rate of 214 lb N/A for the early N treatment compared to 248 lb N/A for the late N treatment. These optimal rates are fairly close to the recommended rates (210-230 lb N/A) from current UI guidelines for Russet Burbank for yields in the 330-350 cwt/A range.

Maximum yields for Summit Russet were somewhat lower (295-302 cwt/A) than those for Russet Burbank (Figure 7). However, the N responses for the two varieties were fairly similar (Fig. 7) with the early N treatment for Summit Russet having a much lower optimal N rate (204 lb N/A) than the late N treatment (261 lb N/A).

Optimum N rates for the 7 varieties are summarized in Table 1. In general, the results form these studies indicate that Bannock Russet requires significantly less N than Russet Burbank, Gem Russet or Summit Russet, while the average optimal N rates for the latter three varieties were fairly similar. Nitrogen timing had relatively little effect on N utilization by Bannock Russet and Gem Russet, but early N was used more efficiently than late N by Russet Burbank and Summit Russet. Alturus and Ranger also preferred split N applications with most of the N applied prior to planting. However, A8893-1 performed best with most of the N applied during tuber bulking.

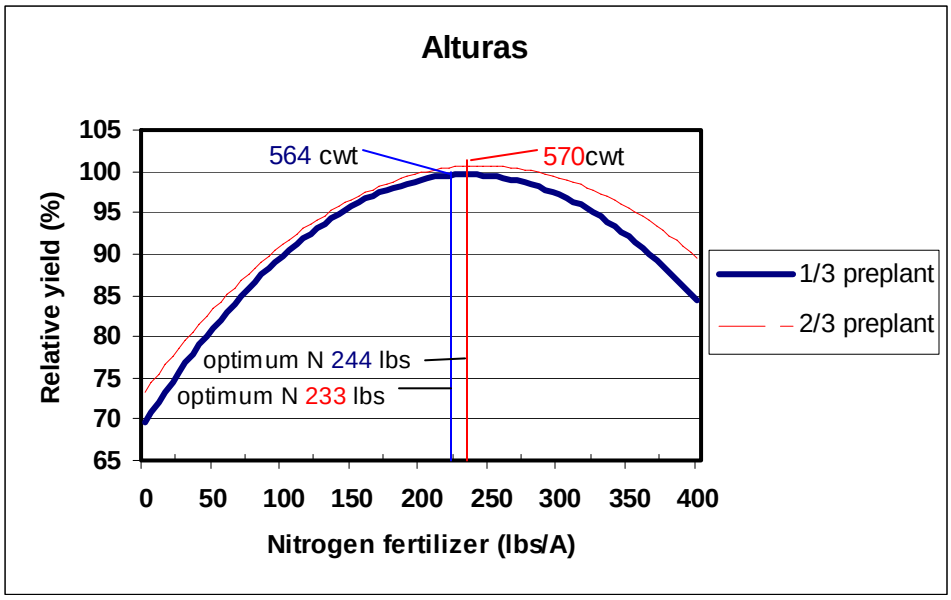

Figure 1. Alturas relative yield as affected by total nitrogen fertilizer.

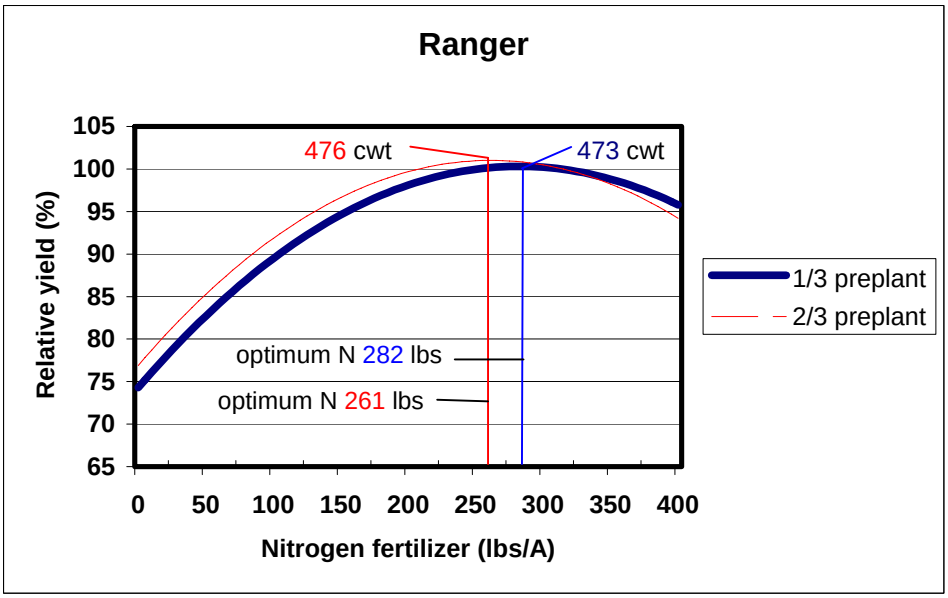

Figure 2. Ranger relative yield as affected by total nitrogen fertilizer.

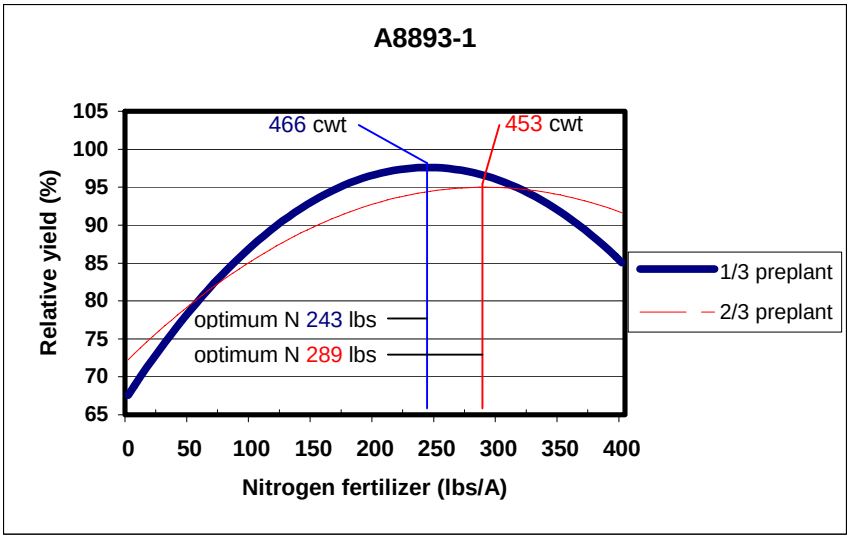

Figure 3. A8893-1 relative yield as affected by total nitrogen fertilizer.

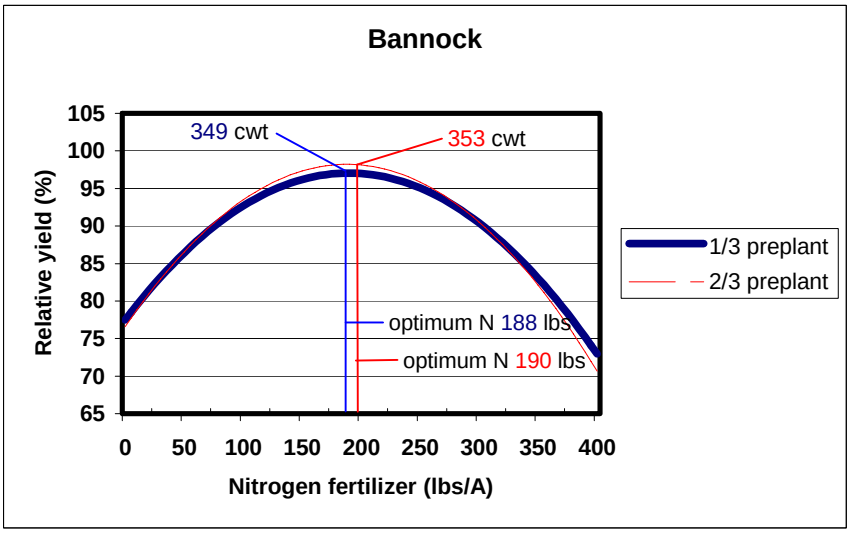

Figure 4. Bannock relative yield as affected by total nitrogen fertilizer.

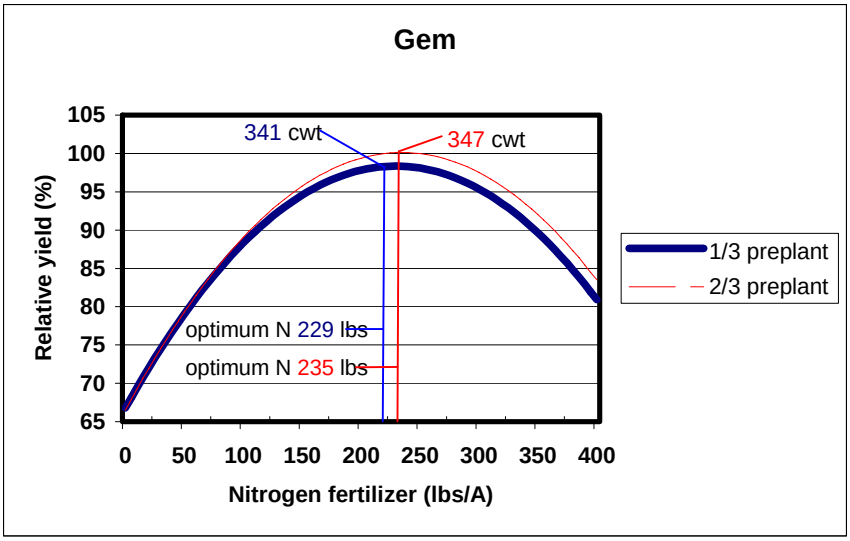

Figure 5. Gem relative yield as affected by total nitrogen fertilizer.

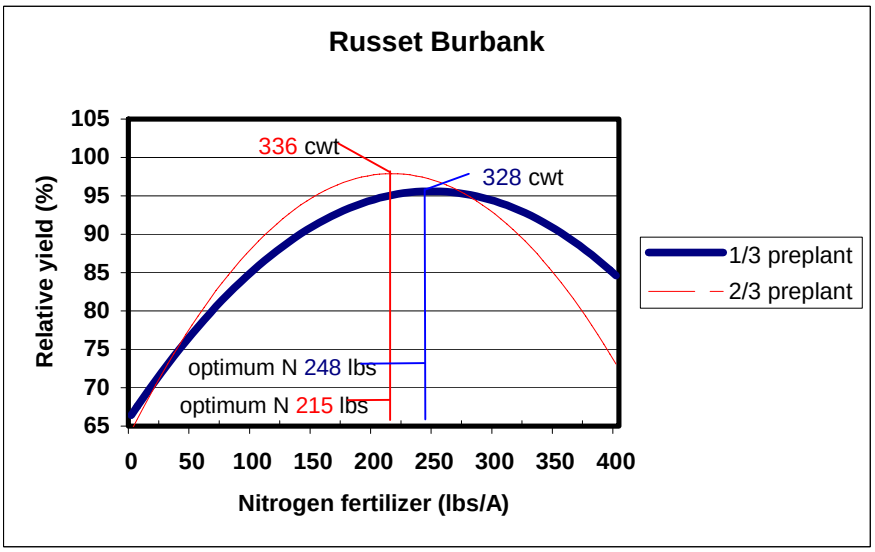

Figure 6. Russet Burbank relative yield as affected by total nitrogen fertilizer.

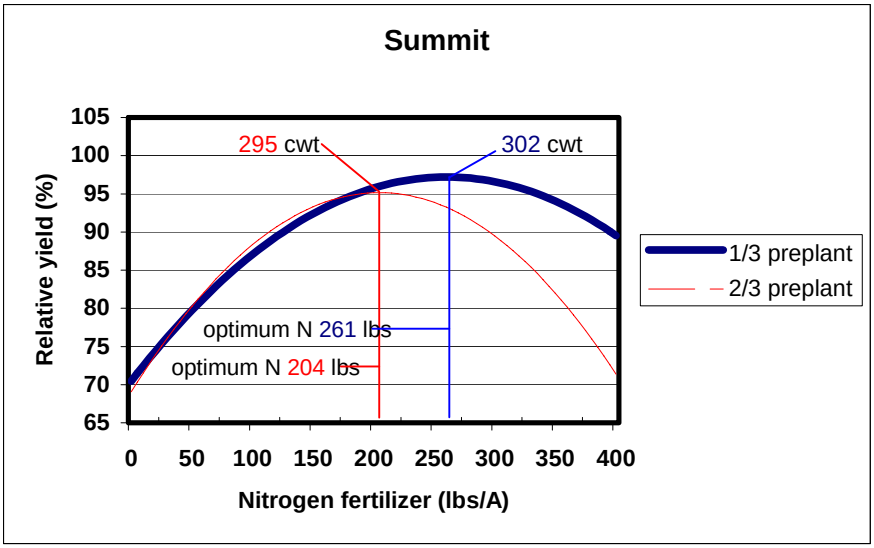

Figure 7. Summit relative yield as affected by total nitrogen fertilizer.

Table 1. Nitrogen rate of varieties at maximum yield

	Early	Late
Aberdeen		
Bannock Russet	188	190
Gem Russet	235	229
Russet Burbank	215	248
Summit Russet	205	261
Parma		
Alturas	233	244
Ranger Russet	261	281
A8893-1	289	243

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