2004

Potato Cultivar Management: Canela and Rio Grande Russet

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INTRODUCTION

Each potato cultivar has its own unique set of cultural management requirements to maximize tuber yield of premium size and grade tubers. The best management guidelines for any cultivar are obtained from field experiments conducted in the specific production area. When management guidelines are tailored for individual cultivars it leads to successful, sustainable, and economic production of cultivars, which results in the optimization of their genetic potential, while minimizing economic inputs and environmental impact.

In this paper, data has been presented that evaluates the effect of nitrogen management on tuber yield, tuber size distribution, and quality of two newly released potato cultivars Canela Russet (AC92009-4RU) and Rio Grande Russet. The effect of irrigation rate and seed piece spacing on tuber yield and quality of Rio Grande Russet is also discussed. The data presented show optimum management practices that could maximize tuber yield and quality, and which could lead to the successful production of the cultivars discussed.

CASE STUDY 1:
Effect of Total N Rate on Tuber Yield and Agronomic N Use Efficiency of Potato Cultivar Canela Russet.

Experimental Procedure: The field experiment was conducted at the San Luis Valley Research Center, Colorado, on a gravelley Sandy loam [loamy-skeletal mixed (calcareous), frigid *Aquic ustorthents*]. The experimental plots were included in a two year barley (*Hordeum vugare* L.)-potato crop rotation. The experiment was arranged in a randomized complete block design with four replications. The N rates are described in Table 1.

Soil samples were collected with an auger before planting. They were air dried and sent to the Colorado State University (CSU) Soil Testing Laboratory for analysis. CSU determined the amount of initial soil nitrate nitrogen (NO_3-N) in the top 12 inches soil surface. Initial available soil NO_3-N was 105 lb N/ac. The background NO_3-N that was applied with irrigation water (20 lb N/ac) was also measured.

At maturity, the center two rows from each plot were harvested and tubers weighed. Tubers were mechanically sized into > 4 oz, marketable size tubers (4-16 oz), medium size marketable tubers (4-10 oz), large marketable size tubers (10-16 oz), and 6-12 oz tuber size. Agronomic N use efficiency (AE_N) was evaluated as increase in tuber yield per quantity of fertilizer applied.

Table 1. Total N fertilizer applied and N fertilizer application schedule during the growing season for Canela Russet (AC92009-4RU).

Total N Rate	Pre-plant N Rate	------------- Weeks After Start of Tuberization --------------		
		1	3	5
		lb N/ac		
0 (125)[1]	0	0	0	0
60 (185)	60	0	0	0
120 (245)	60	20	20	20
180 (305)	60	40	40	40
240 (365)	60	60	60	60

[1] Figures in brackets indicate total available N (applied plus soil and irrigation water N).

Results and Discussion: The N rate for the growing season of 60 lb N/ac (185 lb N/ac available) was the treatment that produced the maximum amount of tubers for total yield and all other tuber size distribution groups (Fig. 1 a and b). At this N rate no tuber external or internal defects were observed, and tuber specific gravity was high [1.096 (Table 2)]. These results are very important because they show that background soil and water N play a significant row in determining optimum N application rate for maximum tuber yield and quality. It is clear that available N greater than 185 lb N/ac reduced total tuber yield produced and reduced the quantity of marketable tuber yield. The results also show the potential negative economic impact and negative N environmental impact from the over-application of N fertilizer since N rates over 60 lb N/ac (185 lb N/ac available N) had much lower agronomic N use efficiency (Fig. 2 a and b). A high AE_N indicates that most of the N applied was used in crop production with a lower potential of N lost to the environment, while a lower AE_N suggests a higher probability that N will be lost to the environment, while the extra money used for over application of N could reduce overall profit margins.

Table 2. Effect of total nitrogen rate on tuber quality of Canela Russet (AC92009-4RU)

Total N Rate (lb/ac)	% External Defect[2]	% Internal Defect[3]	Specific Gravity
0 (125)[1]	0	0	1.097
60 (185)	0	0	1.096
120 (245)	0	0	1.095
180 (305)	1.1	0	1.090
240 (365)	0	0	1.092

[1] Figures in brackets indicate total available N (applied plus soil and irrigation water N).
[2] Includes growth cracks, knobs and misshapes
[3] Includes hollow heart and brown center

CASE STUDY 2:
Effect of Pre-Plant N Rate on Tuber Yield and Agronomic N Use Efficiency of Potato Cultivar Canela Russet (AC92009-4RU).

Experimental Procedure: The soil characteristics of the experimental site, experimental design, and data collection are as described in case study 1. Initial available soil NO_3-N was 80 lb N/ac, and the background NO_3-N applied through the irrigation water was measured to be 20 lb N/ac. Treatments included four pre-plant N rates, 0, 60, 80, and 100 lb N/ac. The remaining N after pre-plant application was applied in three split applications during the growing season. Total N rate was 140 lb N/ac. The N application schedule is described in Table 3.

Results and Discussion: Optimum pre-plant N rate for maximum total yield and marketable tuber yield for Canela Russet was 80 lb N/ac [180 lb N/ac available (Fig. 3 a and b)]. This is evidenced by the increased AE_N at the 80 lb N/ac pre-plant rate, compared to the 60 and 100 lb N/ac pre-plant N rate (fig. 4 a and b). Only 0.6% external tuber defects were observed at the 80 lb/ac pre-plant N rate, with no internal tuber defects and a high tuber specific gravity [1.093 (Table 4)]. Over-application of initial N fertilizer combined with a lower application of N during

Effect of Nitrogen Rate on Tuber Yield of Canela Russet

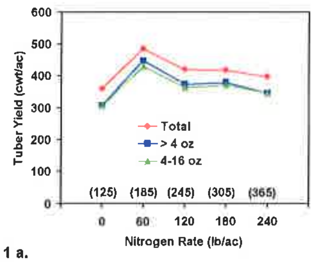


Fig. 1 a.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Effect of Nitrogen Rate on Tuber Size Distribution of Canela Russet

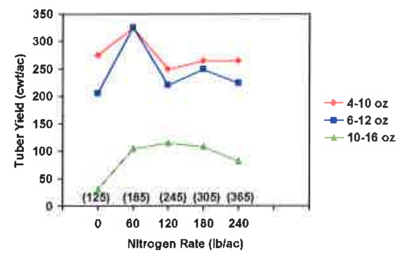


Fig 1 b.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Agronomic N Use Efficiency (Total and Marketable Yield) for Canela Russet

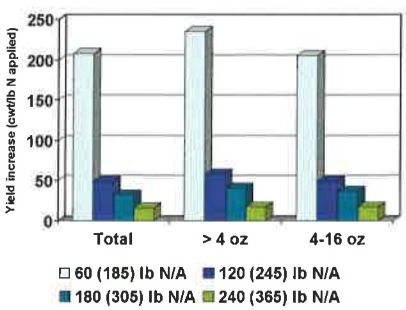


Fig. 2 a.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Agronomic N Use Efficiency (Tuber size distribution) for Canela Russet

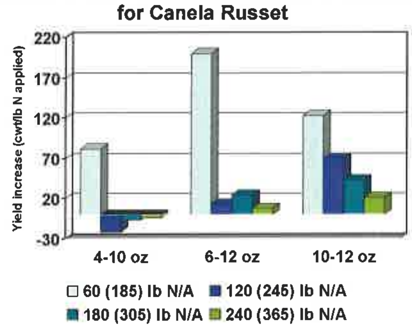
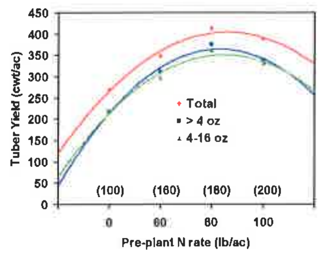


Fig. 2 b

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Effect of Pre-plant N Application Rate on Tuber Yield of Canela Russet

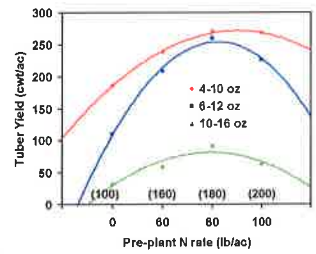


Total N Applied
140 lb/ac
(240 lb/ac)

Fig. 3 a.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Effect of Pre-plant N Application Rate on Tuber Size Distribution of Canela Russet



Total N Applied
140 lb/ac
(226 lb/ac)

Fig. 3 b.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Effect of Pre-Plant N Rate on Agronomic N Use Efficiency of Canela Russet

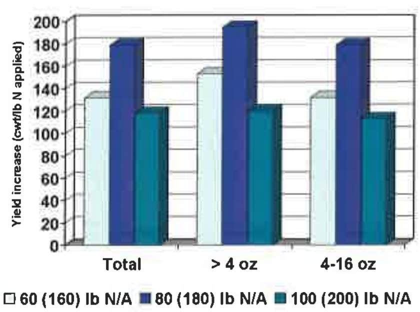


Fig. 4 a.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Effect of Pre-Plant N Rate on Agronomic N Use Efficiency of Canela Russet

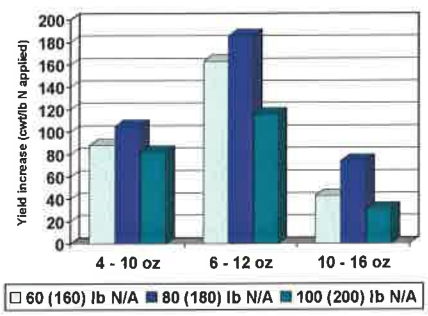


Fig. 4 b.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

the growing season lowered total and marketable tuber yield. The best combination was 80 lb N/ac pre-plant with 60 lb N/ac applied during the growing season to maximize tuber yield and quality.

Table 3. Fertilizer application schedule for the pre-plant N application rate study.

Pre-plant N Rate	Weeks after start of tuberization 1	3	5
	lb/ac		
0 (100)[1]	20	60	60
60 (160)	20	40	20
80 (180)	20	20	20
100 (200)	20	10	10

[1] Figures in brackets indicate total available N (applied plus soil and irrigation water N).

Table 4.Effect of pre-plant N application rate on tuber quality of Canela Russet (AC92009-4RU).

Pre-plant N Rate (lb/ac)[1]	% External Defect[2]	% Internal Defect[3]	Specific Gravity
0 (100)[1]	0	0	1.092
60 (160)	0	0	1.090
80 (180)	0.6	0	1.093
100 (200)	0	1.4	1.094

[1] Figures in brackets indicate total available N (applied plus soil and irrigation water N).
[2] Includes growth cracks, knobs and misshapes
[3] Includes hollow heart and brown center

CASE STUDY 3:
Effect of total N rate on tuber yield and agronomic N use efficiency of potato cultivar Rio Grande Russet.

Experimental Procedure: The soil characteristics of the experimental site, experimental design, treatments, and data collection are as described in case study 1.

Results and Discussion: The optimum N rate for maximum tuber yield and quality was 60 lb N/ac [185 lb N/ac available (fig. 5 a and b)]. Even though the data show no significant difference in total yield and marketable tuber yield for the 60 lb N/ac and the 180 or 240 lb N/ac treatments, an evaluation of the AE_N (fig. 6 a and b) indicate that at the higher N rates, there is a potential for negative economic and environmental impact. Agronomic N use efficiency decreased as N rate increased. The lowest percentage of external tuber defect (1.0%) was observed for the 60 lb N/ac treatment compared to the other treatments (Table 5). No internal tuber defect was observed for the 60 lb N/ac treatment, and specific gravity was high (1.082).

Effect of Nitrogen Rate on Tuber Yield of Rio Grande Russet

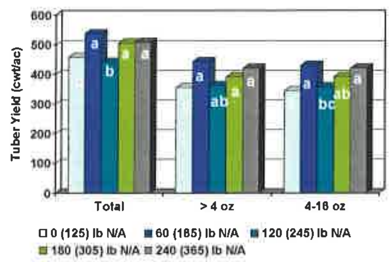


Fig. 5 a.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Effect of Nitrogen Rate on Tuber Size Distribution of Rio Grande Russet

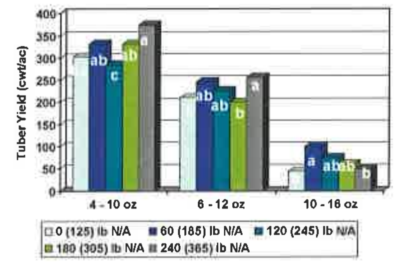


Fig. 5 b.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Agronomic N Use Efficiency of Rio Grande Russet

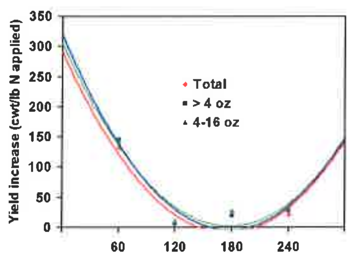


Fig. 6 a.

Nitrogen Rate (lb/ac)

(185) (245) (305) (365)

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Agronomic N Use Efficiency of Rio Grande Russet

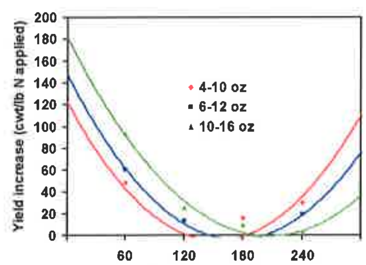


Fig. 6 b.

Nitrogen Rate (lb/ac)

(185) (245) (305) (365)

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Table 5. Effect of total nitrogen rate on tuber quality of Rio Grande Russet

Total N Rate (lb/ac)	% External Defect[2]	% Internal Defect[3]	Specific Gravity
0 (125)[1]	2.7	0	1.086
60 (185)	1.0	0	1.082
120 (245)	3.0	0	1.082
180 (305)	2.0	0	1.079
240 (365)	3.6	0	1.080

[1] Figures in brackets indicate total available N (applied plus soil and irrigation water N).
[2] Includes growth cracks, knobs and misshapes
[3] Includes hollow heart and brown center

CASE STUDY 4:
Effect of pre-plant N rate on tuber yield and agronomic N use efficiency of potato cultivar Rio Grande Russet.

Experimental Procedure: The soil characteristics of the experimental site, experimental design, treatments, and data collection are as described in case study 2.

Results and Discussion: The initial application of 60 lb N/ac (140 lb N/ac available) before planting and, subsequent application of the remaining N required during the growing season increased total and marketable tuber yield of Rio Grande Russet, compared to the other three treatments (fig. 7 a and b). Any increase in the initial application of N fertilizer above 60 lb N/ac reduced tuber yield and increased percent tuber external defects (Table 6). The Agronomic N use efficiency decreased as pre-plant N rate was increased form 60 to 100 lb N/ac (fig. 8 a and b), indicating that there is no economic gain in putting more fertilizer upfront and less during the growing season. In this study, the best combination of N fertilizer application was 60 lb N/ac pre-plant and 80 lb N/ac during the growing season.

Table 6 .Effect of pre-plant N application rate on tuber quality of Rio Grande Russet.

Pre-plant N Rate (lb/ac)[1]	% External Defect[2]	% Internal Defect[3]	Specific Gravity
0 (100)[1]	0.7	0	1.080
60 (160)	1.3	0	1.082
80 (180)	3.8	0	1.081
100 (200)	2.0	1.6	1.082

[1] Figures in brackets indicate total available N (applied plus soil and irrigation water N).
[2] Includes growth cracks, knobs and misshapes
[3] Includes hollow heart and brown center

Effect of Pre-plant N Application Rate on Tuber Yield of Rio Grande Russet

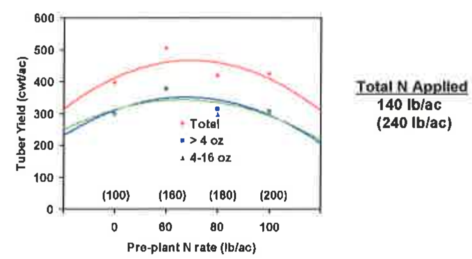


Fig. 7 a.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N

Effect of Pre-plant N Application Rate on Tuber Size Distribution of Rio Grande Russet

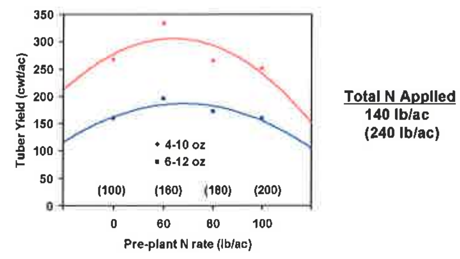


Fig. 7 b.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Effect of Pre-Plant N Rate on Agronomic N Use Efficiency of Rio Grande Russet

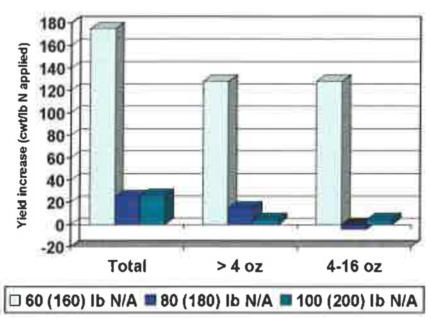


Fig. 8 a.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

Effect of Pre-Plant N Rate on Agronomic N Use Efficiency of Rio Grande Russet

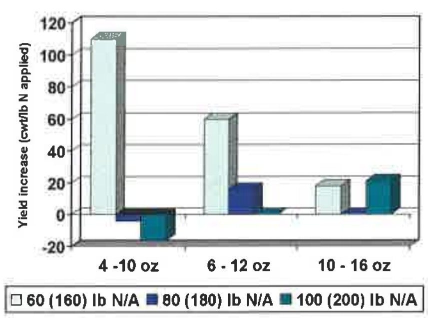


Fig. 8 b.

Figures in brackets indicate available soil nitrogen (applied N + soil and irrigation water N)

CASE STUDY 5:
Effect of irrigation rate and seed piece spacing on tuber yield and quality of Rio Grande Russet.

Experimental Procedure: The soil characteristics of the experimental site and data collection are as described in case study 1. The experiment was arranged in a split plot design with irrigation rate as the main plot factor and in-row seed spacing as the split plot factor. Treatments included two irrigation rates, and three in-row seed piece spacing randomized within each irrigation rate treatment. The two irrigation rate treatments were 100% ET (19.8 inches of water applied plus rainfall during the growing season) and 77% ET (15.2 inches of water applied plus rainfall during the growing season). Seed spacing treatments were 10, 12, and 14 inches.

Results and Discussion: The statistical analysis indicated an interaction effect between irrigation rate and in-row seed piece spacing. This means that the amount of water needed for optimum yield depends on in-row seed piece spacing. When seed was planted at 14 in. spacing, Rio Grande Russet produced maximum total and marketable tuber yield at the higher irrigation rate (19.8 inches of water). Conversely, with the exception of the large marketable size tubers (10-16 oz), the lowest tuber yields were produced when 15.2 inches of water was applied at the 14 in. seed spacing (fig. 9 a and b). It was interesting to note that at seed spacing of 10 or 12 inches, irrigation rate could be reduced by 23% (15.2 inches) to produce similar total and marketable size tuber yield as the 19.8 inch irrigation rate. The results indicate that at a spacing of 10 or 12 inches, optimum tuber yield and high tuber quality of Rio Grande Russet can be produced with total irrigation rate (applied plus rain water) of 15.2 inches. Tuber external defect was higher (6.6%) at the high irrigation rate compared to 2.7% for the reduced irrigation rate, and tuber specific gravity was high for the reduced irrigation rate (Table 7).

Table 7. Effect of total irrigation rate on tuber quality of Rio Grande Russet

Irrigation rate and seed spacing	% External Defects[2]	% Internal Defects[3]	Specific Gravity
100%/10 inch[1]	0.4	0	1.083
100%/12 inch	6.6	1.1	1.083
100%/14 inch	2.8	2.1	1.083
77%/10 inch	1.8	0	1.088
77%/12 inch	2.7	1.7	1.087
77%/14 inch	4.5	1.9	1.087

1 100% = Full ET plus rain water (19.8 in.), 77% = 77% of full ET plus rain water (15.2 in.)
2 Includes growth cracks, knobs and misshapes
3 Includes hollow heart and brown center

SUMMARY AND CONCLUSION

Results from these studies clearly show that nitrogen management is key in maximizing tuber yield and quality of Canela Russet and Rio Grande Russet. The Results are also unique in showing that over-application of initial N fertilizer not only reduced the agronomic N use efficiency, thereby increasing the potential for N losses to the environment, but can also contribute to lower total tuber yield and quality. The results show that background soil and water N play a significant row in determining optimum N application rate for maximum tuber yield and quality.

It is recommended that farmers develop a comprehensive N management plan including the accounting for other N sources such as initial soil NO_3-N and NO_3-N in background irrigation water and N cycling from cover crops.

Irrigation water for agriculture has become a concern in this region, and the judicious use of water for optimum production of potatoes should be practiced. Results from this study show that optimum tuber yield and quality of Rio Grande Russet can be produced with a total of 15.2 inches of irrigation and rain water when seed is planted at 12 inch spacing.

Effect of Irrigation Rate and Seed Piece Spacing on Tuber Yield of Rio Grande Russet

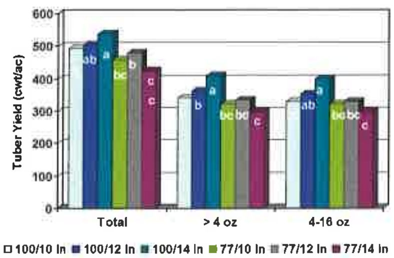


Fig. 9 a.

Legend: 100 = Full ET plus rainfall (19.8 inches)

77 = 77% ET plus rainfall (15.2 inches)

Effect of Irrigation Rate and Seed Piece Spacing on Tuber Size Distribution of Rio Grande Russet

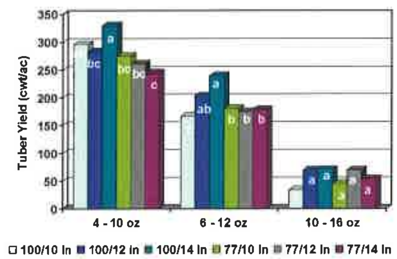


Fig. 9 b.

Legend: 100 = Full ET plus rainfall (19.8 inches)

77 = 77% ET plus rainfall (15.2 inches)