2021 Research Report

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Introduction

Each potato cultivar has its own unique set of cultural management requirements to maximize yield of premium size and quality tubers. Therefore, cultural management practices that maximize tuber production and quality of each potato cultivar must be developed. The best guidelines for nutrient management, irrigation water management, plant population management, vine kill management, and other cultural management practices are obtained from field experiments conducted in replicated trials. New cultivars are much more successful when release is accompanied by cultivar specific management guidelines. Information presented in this report reveals management practices that are agronomically sound, economically advantageous, and environmentally responsible, while optimizing potato tuber yield and quality.

In 2021, potato cultivars were evaluated under Colorado production conditions for their response to nitrogen fertilizer application rates, nitrogen fertilizer application timings, phosphorus fertilizer application management, and plant population (in-row seed piece spacing) management.

Nitrogen Application Rate Studies

Materials and Methods

The field studies were laid out as randomized complete block design. Potato cultivars CO11009-3RU and Reveille Russet were used in the study. Treatments included nitrogen (N) application rates of 60, 120,180 and 240 lb. N/ac. A control treatment was included where no nitrogen fertilizer was applied. Each treatment was replicated four times.

Soil samples were taken from the experimental site in the spring of 2021. The soil samples were analyzed for residual soil nitrate nitrogen as well as other soil nutrients. Water samples were taken from irrigation wells and analyzed for nitrate nitrogen concentration. The residual soil and irrigation water nitrate nitrogen concentration added up to 55 lb N/ac. for the Reveille Russet experimental field and 45 lb N/ac. for cultivar CO11009-3RU experimental field. Knowledge of residual soil and irrigation water nitrate nitrogen content is important to help estimate how much nitrogen fertilizer will be needed to apply to the crop for optimum tuber yield and quality. Residual soil N + irrigation water N + applied N fertilizer = available nitrogen (N) to the plant for the growing season.

Sixty lb. N/ac (60 lb N/acre) was applied pre-plant to all plots except the control treatment plots. The remaining required N for each treatment was applied in-season in split applications. Ammonium thiosulfate (28-0-0-5) was used as source of nitrogen fertilizer in this study.

In-season N application started after tuber formation. In-season N fertilizer applications were done by applying 10-20 lb. N/acre at weekly intervals until all required N rate for a particular treatment was met.

Potato seed piece were cut and suberized for 7 days before planting. CO11009-3RU and Reveille Russet were planted on May 4, 2021. Vines were desiccated on September 10, 2021. Reveille Russet and CO11009-3RU tubers were harvested on September 20 and 22, 2021, respectively.

Results

Reveille Russet:

Petiole Nitrate N Concentration

The sufficiency level for petiole nitrate N concentration during the growing season should range from 18,000 to 20,000 ppm at tuber initiation, 15,000 to 18,000 ppm during early tuber bulking, 7,000 to 15,000 ppm during mid tuber bulking, and 3,000 to 5,000 ppm during tuber maturation (Figure 1). Petiole nitrate N concentration above these levels did not improve tuber yield or tuber quality of Reveille Russet (figure 2, 3, and Table 1).

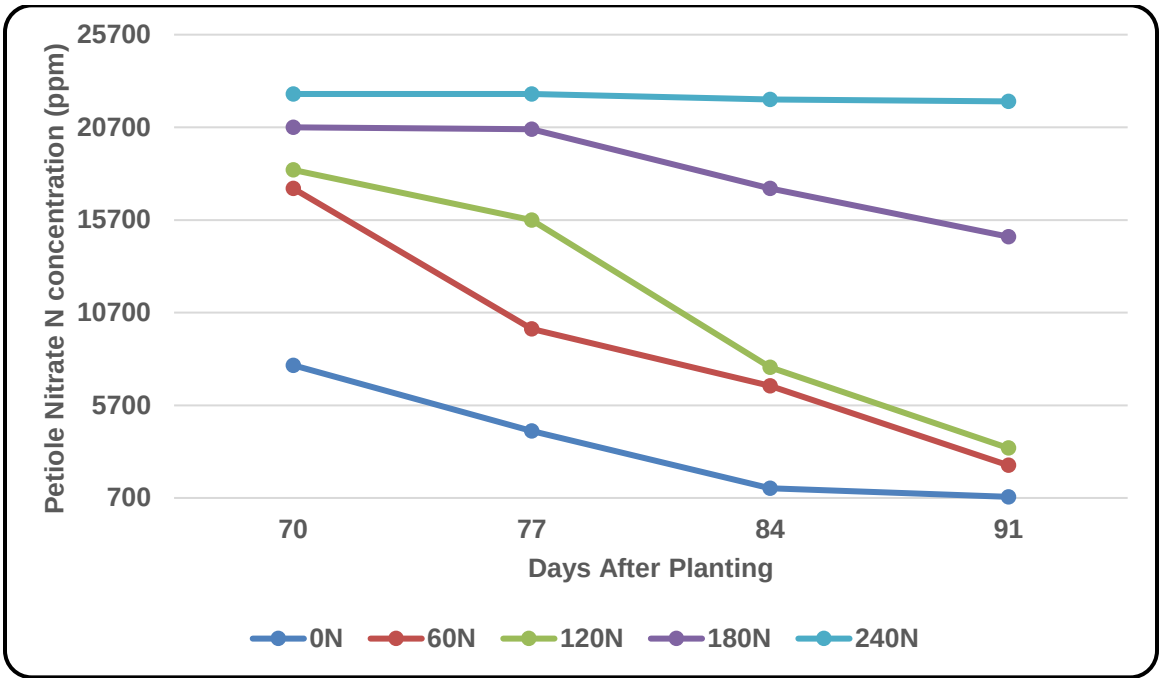

Figure 1. Petiole nitrate nitrogen concentration of potato cultivar Reveille Russet as influenced by nitrogen application rate, 2021.

Reveille Russet:

Mean Tuber Weight

Application of 120 lb. N/acre increased mean tuber weight, compared to all other nitrogen application rate treatments; however, the increase in tuber weight was not statistically different from tuber weights observed from other N application rate treatments (figure 2).

Reveille Russet:

Tuber Yield and Tuber Size Distribution

Reveille Russet did respond to N application rate in this study. Application rates below 120 lb N/acre reduced total tuber yield, and the yield of all tuber size groups evaluated (figure 3). No significant difference was observed in any of the yields evaluated with nitrogen application rates of 120 lb N/acre to 240 lb N/acre. This indicates that an application rate of 120 lb N/acre is sufficient for optimum tuber yield of Reveille Russet (figure 3).

Reveille Russet:

Tuber Quality

Nitrogen application rate did not influence tuber external defects of Reveille Russet (Table 1). No hollow heart was observed in any of the tubers harvested. Tuber specific gravity was observed to decrease when N application rate was increased above 120 lb N/acre (Table 1).

Reveille Russet:

Net Returns from Applying Different Nitrogen Fertilizer Rates

Net returns was higher for > 4 oz and > 6 oz tuber yields when 180 lb N/acre was applied to Reveille Russet. However, higher net returns was observed for > 10 oz tuber yields when 120 lb N/acre was applied. N application rate for Reveille Russet is recommended to be between 120 to 180 lb N/acre in this study, indicating a total required N of between 175 to 235 lb N/acre (soil + irrigation water + applied N) for Reveille Russet.

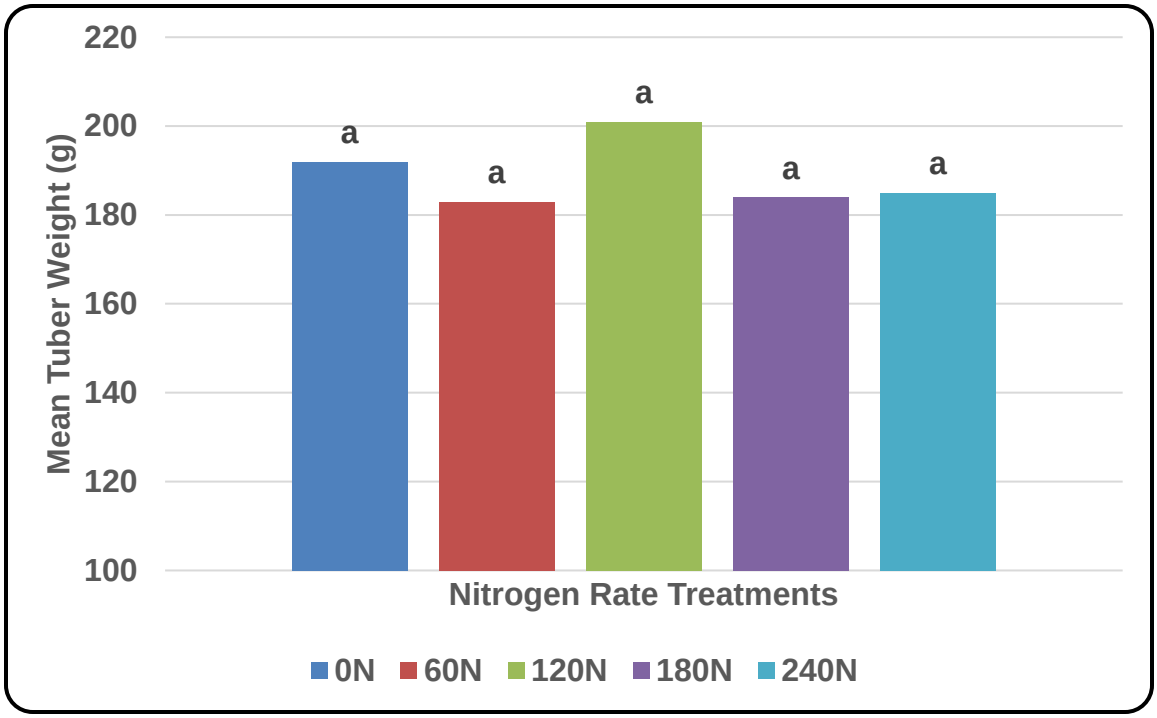

Figure 2. Mean tuber weight of Reveille Russet as influenced by nitrogen application rate, 2021

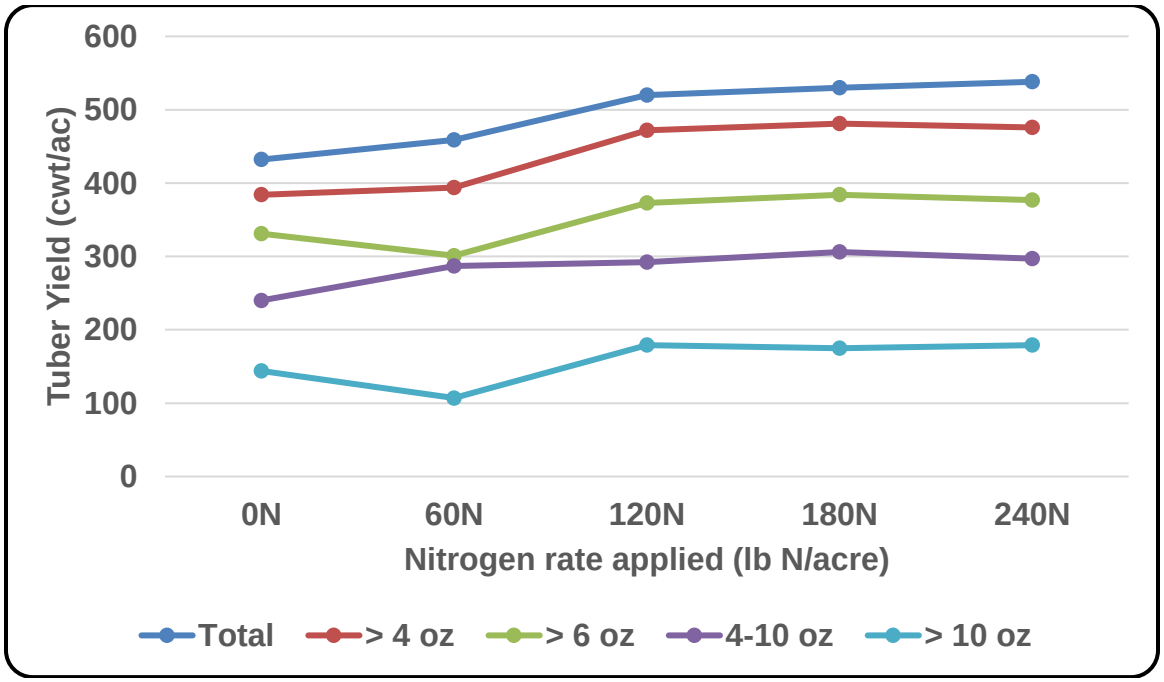

Figure 3. Tuber yield of Reveille Russet as influenced by nitrogen application rate, 2021

Table 1. Effect of nitrogen application rate on tuber quality of Reveille Russet, 2021

Treatment Applied (lb N/Acre)	% Growth Cracks	% Misshapes	% External Defects*	% Hollow Heart	Specific Gravity
0 N	1.0 a	2.5 a	3.5 a	0	1.088 *a***
60 N	0.2 a	1.5 a	1.7 a	0	1.085 *ab*
120 N	1.0 a	0.7 a	1.7 a	0	1.085 *ab*
180 N	0.0 a	0.5 a	0.5 a	0	1.082 *bc*
240 N	0.8 a	2.2 a	3.0 a	0	1.079 *c*

*Includes growth cracks and misshapes

** Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 2. Effect of nitrogen application rate on net returns for Reveille Russet when considering nitrogen fertilizer cost only, with all other costs fixed, 2021.

Treatment	> 4 oz	> 6 oz	> 10 oz
	Net Returns ($/Acre)		
0 N	4,224	4,303	2,016
60 N	4,318	3,897	1,482
120 N	5,161	4,818	2,475
180 N	5,244	4,945	2,403
240 N	5,173	4,838	2,443

CO11009-3RU:

Petiole Nitrate N Concentration

The sufficiency level for petiole nitrate N concentration during the growing season should range from 15,000 to 17,000 ppm at tuber initiation, 11,000 to 13,000 ppm during early tuber bulking, 5,000 to 6,000 ppm during mid tuber bulking, and 3,000 to 4,000 ppm during tuber maturation (Figure 4). Petiole nitrate N concentration above these levels did not improve tuber yield or tuber quality (figure 5, 6, and Table 3).

CO11009-3RU:

Mean Tuber Weight

Nitrogen application rate of 120 lb N/acre optimized mean tuber weight of potato cultivar CO11009-3RU (Figure 5). Nitrogen application rate above 120 lb N/acre did reduce tuber weight of CO11009-3RU.

CO11009-3RU:

Tuber Yield and Tuber Size Distribution

Total tuber yield, and the yield of all other size distribution groups did respond to nitrogen application rate. Total tuber yield and the yield of all other tuber size groups peaked at application rate of 120 lb N/acre, with the exception of 4-10 oz. tuber yield which reached its

peak with N rate of 60 lb N/acre. Application rates above the optimum 120 lb N/acre resulted in decrease in tuber yields (figure 6).

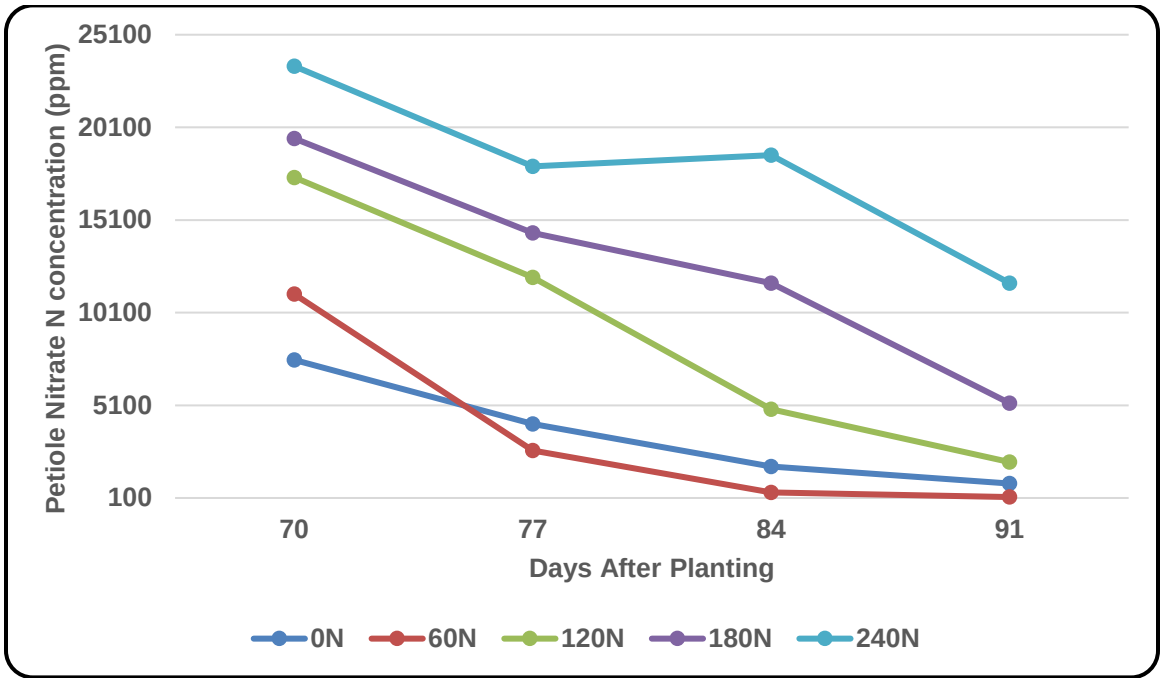

Figure 4. Petiole nitrate nitrogen concentration of potato cultivar CO11009-3RU as influenced by nitrogen application rate, 2021.

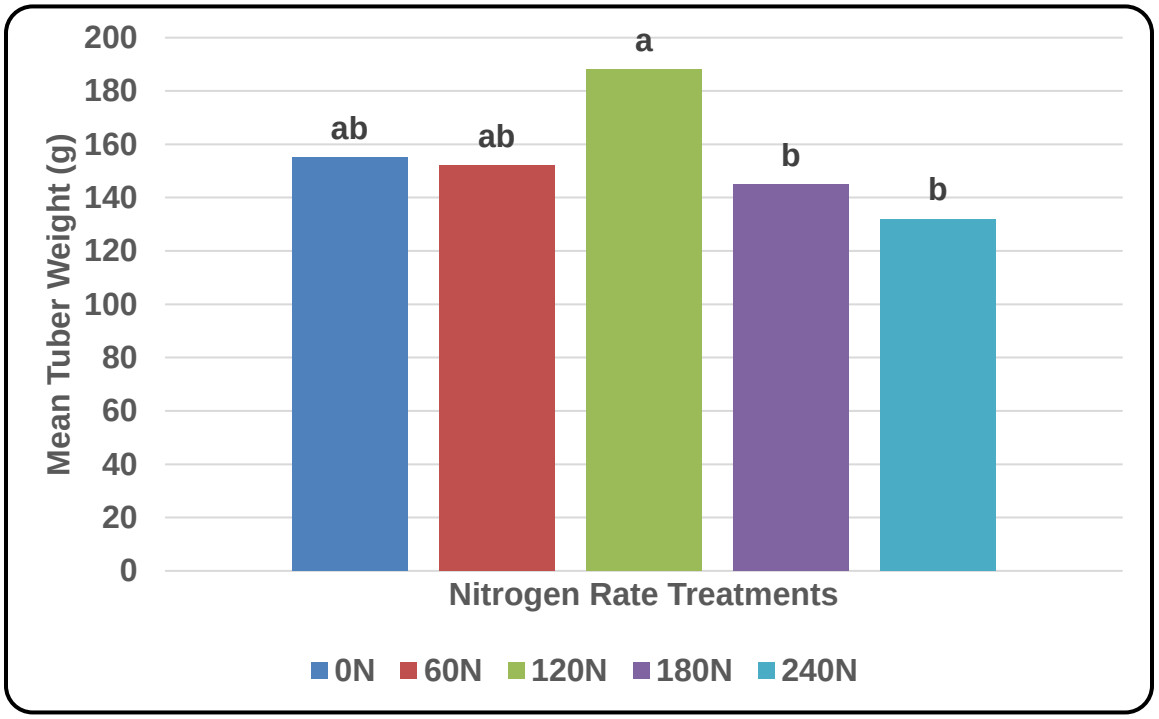

Figure 5. Mean tuber weight of potato cultivar CO11009-3RU as influenced by nitrogen application rate, 2021

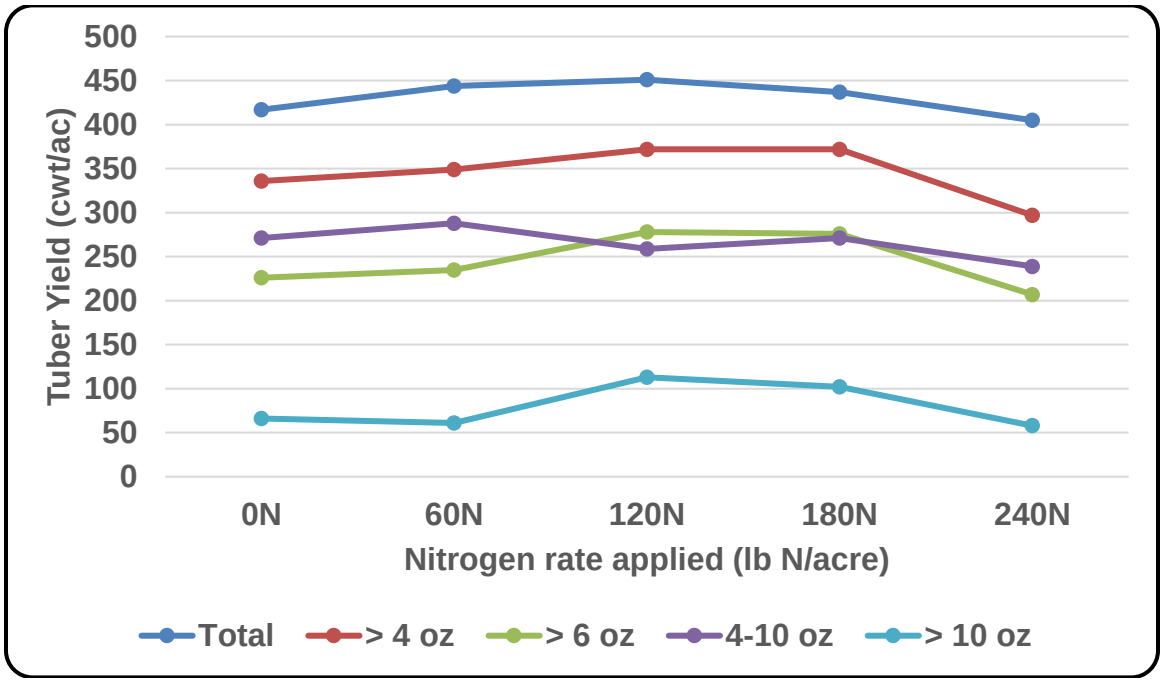

Figure 6. Tuber yield of potato cultivar CO11009-3RU as influenced by nitrogen application rate, 2021

CO11009-3RU:

Tuber Quality

Nitrogen application rate did not influence tuber external defects of potato cultivar CO11009-3RU (Table 3). Data obtained from this cultivar showed high susceptibility to hollow heart. However, application rate of 240 lb N/acre reduced tuber hollow heart by 66% when compared to the control treatment. We cannot confirm whether the high incidence of hollow heart observed in this cultivar was due to the severe hail damage to the crop on June 25, 2021. Further studies will confirm the susceptibility of the cultivar to hollow heart. Tuber specific gravity decreased with increasing N application rate, but the specific gravities were not significantly different from each other (Table 3).

CO11009-3RU:

Net Returns from Applying Different Nitrogen Fertilizer Rates

Nitrogen application rate of 120 lb N/acre maximized net returns of > 4 oz, > 6 oz, and > 10 oz tuber yields of potato cultivar CO11009-3RU (Table 4).

Table 3. Effect of nitrogen application rate on tuber quality of potato cultivar CO11009-3RU, 2021

Treatment Applied (lb N/Acre)	% Growth Cracks	% Knobs	% External Defects*	% Hollow Heart	Specific Gravity
0 N	0.0 *a*	0.3 *a*	0.3 *a*	17.5 *a*	1.098 *a***
60 N	0.0 *a*	0.0 *a*	0.0 *a*	14.3 *a*	1.100 *a*
120 N	0.0 *a*	0.0 *a*	0.0 *a*	18.3 *a*	1.098 *a*
180 N	0.0 *a*	0.0 *a*	0.0 *a*	15.4 *a*	1.095 *a*
240 N	0.3 *a*	0.0 *a*	0.3 *a*	5.9 *b*	1.094 *a*

*Includes growth cracks, knobs, and misshapes

** Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 4. Effect of nitrogen application rate on net returns for potato cultivar CO11009-3RU when considering nitrogen fertilizer cost only, with all other costs fixed, 2021.

Treatment	> 4 oz	> 6 oz	> 10 oz
	Net Returns ($/Acre)		
0 N	3,696	2,938	924
60 N	3,823	3,039	838
120 N	4,061	3,583	1,551
180 N	4,045	3,541	1,381
240 N	3,204	2,628	749

Summary of Nitrogen Application Rate Studies

Total required N for Reveille Russet is estimated to be between 175 to 200 lb N/acre. The estimated required N includes residual soil N, irrigation water N, and applied N. Therefore, always subtract the residual soil N and irrigation water N from the stated range of required estimate to arrive at the quantity of N to apply for optimum yield and maximum net returns. For potato cultivar CO11009-3RU, the total required N for optimum tuber yield and maximum net returns was observed to be 165 lb N/ac. Subtract the residual soil N and irrigation water N from the total required N to arrive at the quantity of N to apply for the season.

Nitrogen Application Timing Studies

Materials and Methods

Potato cultivars Reveille Russet and CO010085-1RU were planted for this field study. The study was laid out as a randomized complete block design, with five treatments. Each treatment was replicated four times. Treatments included 1) In-Season nitrogen (N) fertilizer application (In-Season), where no nitrogen was applied at planting, but all required N was split applied during the growing season 2) Applying all required N at planting (All at planting), 3) Applying 66% of the required N at planting and the rest split applied during the growing season (66%), 4) Applying 50% of the required N at planting and the remainder split applied during the growing season (50%), 5) Applying 33% of the required N at planting and the rest split applied during the growing season (33%). The total amount of N fertilizer applied for each treatment was 160 lb. N/acre. Residual N fertilizer in the Reveille Russet and CO010085-1RU experimental fields were, 54.0 and 65.0 lb N/acre, respectively.

In-season N fertilizer applications were done by applying 10-20 lb. N/acre at weekly intervals until the required N for each treatment was met. In-season N fertilizer application was started during the first week of July, after tuber formation.

Potato seed pieces were machine planted at a spacing of 12 inches within rows and 34 inches between rows on May 5, 2021. All vines were killed on September 10, 2021. Potato tubers were harvested on September 22, 2021.

Results

Reveille Russet

Tuber Bulking

Nitrogen application timing did influence tuber bulking of Reveille Russet. Application of 33% of the required N pre-plant, and in-season application of N where no N fertilizer was applied pre-plant, did improve early tuber bulking at 98 days after planting (DAP) – Fig 7. These two application timing treatments continued to improve tuber bulking at 118 DAP, compared to other application timing treatments (fig 7).

Total Tuber Yield and Tuber Size Distribution

Reveille Russet seem to tolerate a wide range of N application timing. Total tuber yield, and the yield of all tuber size distribution groups evaluated in this study did not differ from each other when no N fertilizer was applied pre-plant (in-season N application), or when all N fertilizer was applied pre-plant (Table 5). Also, application of 66 or 50% of required N pre-plant did not influence tuber yield. In general, applying 33% of required N pre-plant reduced tuber yield in some of the tuber size groups evaluated (Table 5).

Tuber Quality

Nitrogen application timing did not impact tuber external or internal defects of Reveille Russet. Similarly, tuber specific gravity did not differ among the nitrogen application timing treatments (Table 6).

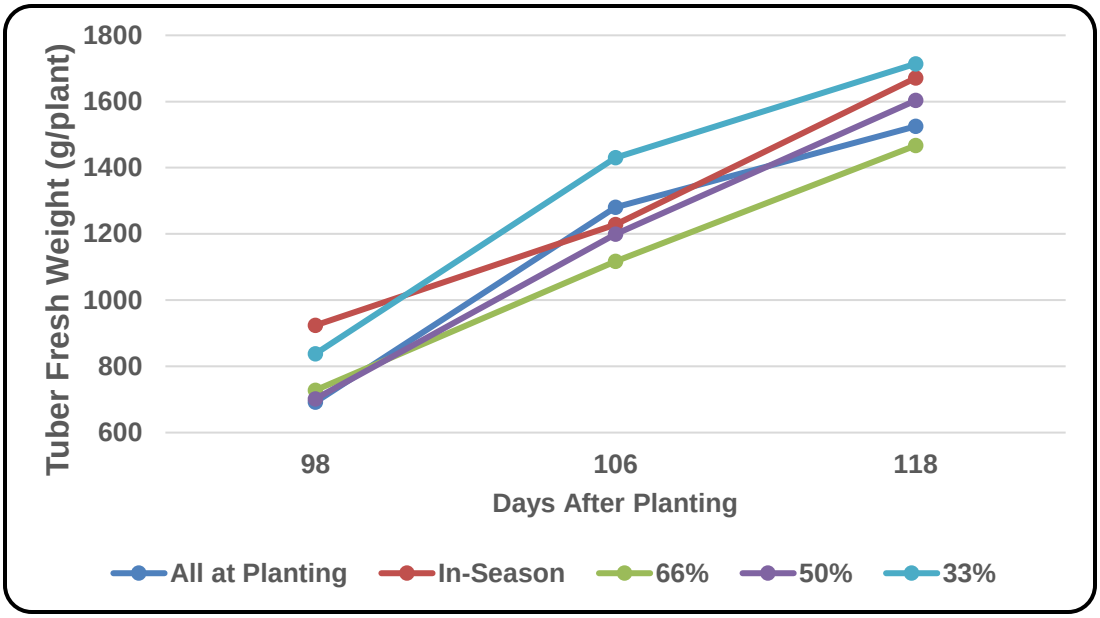

Figure 7. Tuber bulking of Reveille Russet as influenced by nitrogen fertilizer application timing, 2021.

Table 5. Effect of nitrogen application timing on tuber yield and tuber size distribution of Reveille Russet, 2021

Treatment	Total	> 4 oz.	> 6 oz.	4-10 oz	4-16 oz.	6-16 oz.
	Tuber Yield (cwt/acre)					
All at Planting	524 *ab**	470 *a*	376 *a*	304 *ab*	433 *ab*	338 *a*
In-Season	533 *a*	460 *ab*	350 *ab*	325 *a*	447 *a*	337 *a*
66%	536 *a*	458 *ab*	350 *ab*	322 *a*	420 *ab*	312 *a*
50%	523 *ab*	445 *ab*	334 *b*	323 *a*	419 *ab*	307*a*
33%	503 *b*	436 *b*	343 a*b*	282 *b*	408 *b*	316 *a*

* Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 6. Effect of nitrogen application timing on tuber quality of Reveille Russet, 2021

Treatment Applied	% Growth Cracks	% Knobs	% Misshapes	% External Defects*	Specific Gravity
All at Planting	1.0 *a*	0.6 *a*	0.7 *a*	2.3 *a*	1.081 *a***
In-Season	0.0 *a*	0.0 *a*	0.0 *a*	0.0 *a*	1.078 *a*
66%	1.0 *a*	0.7 *a*	0.0 *a*	1.7 *a*	1.080 *a*
50%	0.0 *a*	0.0 *a*	0.0 *a*	0.0 *a*	1.081 *a*
33%	1.1 *a*	0.0 *a*	0.5 *a*	1.6 *a*	1.080 *a*

*Includes growth cracks, knobs, and misshapes

** Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

CO10085-1RU

Tuber Bulking

Application of all required N fertilizer at pre-plant did delay tuber bulking and also reduced tuber bulking in potato cultivar CO10085-1RU (fig 8).Tuber bulking did not differ among all other N fertilizer application timing treatments (figure 8).

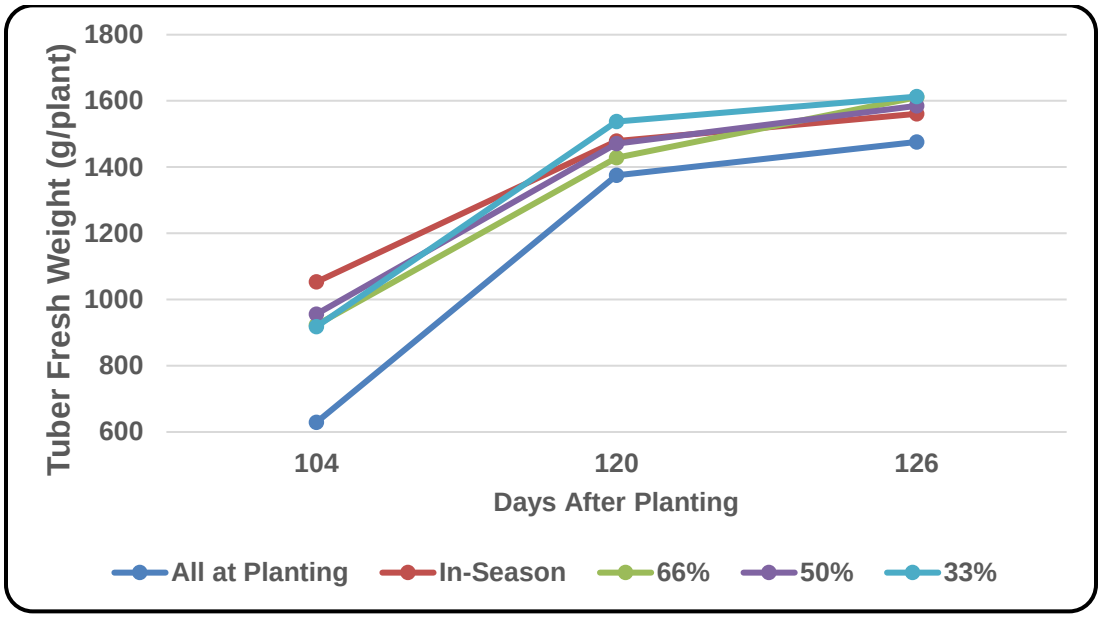

Figure 8. Tuber bulking of potato cultivar CO10085-1RU as influenced by nitrogen fertilizer application timing, 2021.

Total Tuber Yield and Yield of Tuber Size Distribution Groups

Applying all required N pre-plant did reduce total tuber yield and the yield of all tuber size distribution groups evaluated in this study (Table 6). All other N application timing treatments did not differ in tuber yields among each other. The yield data indicate that N application timing can be flexible for potato cultivar CO10085-1RU, except that all required N cannot be applied pre-plant.

Tuber Quality

The only two N application timing treatments that caused differences in tuber specific gravity were, in-season N fertilizer application, where no N fertilizer was applied pre-plant, and the application of 66% of required N fertilizer at planting, with the remaining 33% applied in-season in split applications. In-season application of N fertilizer significantly reduced tuber specific gravity of potato cultivar CO10085-1RU, when compared to pre-plant application of 66% of the

required N. Pre-plant application of 66% of required N did maximize tuber specific gravity to 1.094 (figure 9). All other application timing treatments did not differ in tuber specific gravity. No external or internal tuber defects were observed in any of the tubers harvested.

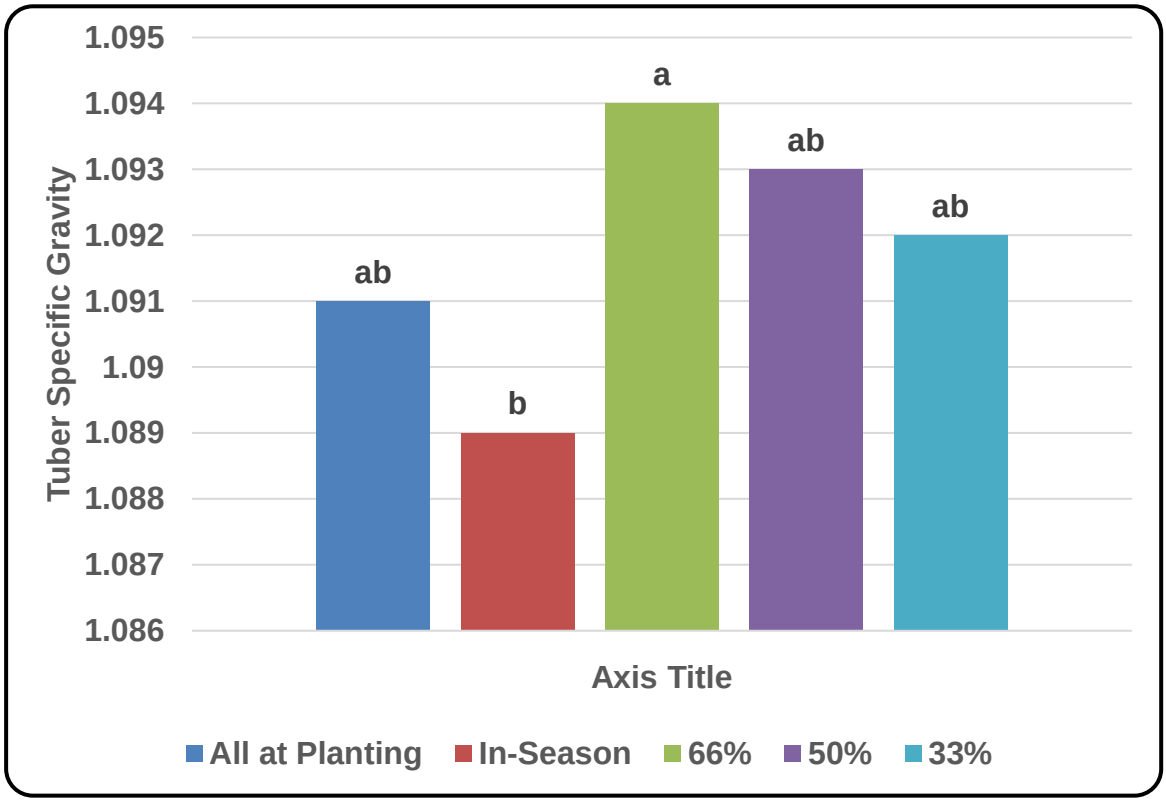

Figure 9. Tuber specific gravity of potato cultivar CO10085-1RU as influenced by nitrogen fertilizer application timing, 2021.

Table 6. Effect of nitrogen application timing on tuber yield and tuber size distribution of potato cultivar CO10085-1RU, 2021

Treatment	Total	> 4 oz.	> 6 oz.	4-10 oz	4-16 oz.	6-16 oz.
	Tuber Yield (cwt/acre)					
All at Planting	455 *b**	348 *b*	236 *b*	270 *b*	339 *b*	227 *a*
In-Season	479 *ab*	383 *a*	267 *a*	295 *ab*	372 *a*	255 *a*
66%	492 *a*	379 *a*	248 *ab*	303 *ab*	371 *a*	239 *a*
50%	492 *a*	378 *ab*	253 a*b*	295 *ab*	372 *a*	247*a*
33%	497 *a*	384 *a*	246 a*b*	311 a*b*	369 a*b*	230 *a*

* Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Summary of Nitrogen Application Timing Studies

Reveille Russet can tolerate a wide range of nitrogen fertilizer application timings. However, applying 33% of the required N pre-plant and applying the remaining 66% of the required N in-season could reduce yield of some tuber size groups.

For potato cultivar CO10085-1RU, one cannot apply all required N pre-plant since that kind of management system can reduce tuber bulking and tuber yields. Potato cultivar CO10085-1RU can be flexible with all other N application timing management practices, without affecting tuber bulking or tuber yields.

Plant Population Management (In-Row Seed Spacing) Studies

Materials and Methods

Potato cultivars Reveille Russet, CO11009-3RU, and CO10085-1RU were evaluated for their response to in-row seed spacing. The studies were laid out in the field as randomized complete block design. In-row seed spacing treatments included planting seed at 10, 12, 14, and 16 inches spacing. Each treatment was replicated four times. Each plot consisted of three potato rows spaced 34 inches apart. All potato seed were planted by hand. Potato seed piece were cut to a size of 2.5 to 3.5 oz and suberized for 7 days before planting on May 19, 2021. Vines of all three cultivars were desiccated on September 10, 2021. Potato cultivars CO11009-3RU and CO10085-1RU were harvested on September 27 and Reveille Russet was harvested on September 28, 2021.
A cost benefit analysis was computed for each of the four in-row seed spacing treatments to evaluate net returns obtained for each plant population for each potato cultivar. All operational costs were fixed, with the exception of seed cost for planting which varied from plant population to plant population.

Results

Reveille Russet:

Tuber Yield and Tuber Size Distribution

Planting Reveille Russet potato seed at a spacing of 14 or 16 inches within rows produced higher large marketable size (> 6 oz) tuber yields. But planting at in-row spacing of 10 or 12 inches maximized the yield of medium size (4-10 oz) tubers (Table 7). In-row seed spacing did not influence total, marketable (> 4 oz) or premium size (> 10 oz) tuber yield in Reveille Russet (Table 7).

Tuber Quality

In-row seed spacing did not influence tuber external or internal defects in Reveille Russet. Tuber specific gravity did not differ among the different in row seed spacings (Table 8).

Net Returns from Reveille Russet as influenced by in-row seed spacing

Maximum net returns for total tuber yield was obtained when Reveille Russet seed was planted at in-row spacing of 12 inches (Table 9). However, planting seed at in-row spacing of 16 inches generated maximum net returns for marketable (> 4 oz), large marketable (> 6 oz), and premium size (> 10 oz) tuber yields (Table 10, 11, and 12).

Table 7. Effect of in-row seed spacing on tuber yield and tuber size distribution of Reveille Russet, 2021.

In-row seed spacing (inches)	Total	> 4 oz	> 6 oz	> 10 oz	4-10 oz
	Tuber Yield (cwt/acre)				
10	509 *a**	420 *a*	300 *ab*	58 *a*	323 *a*
12	515 *a*	414 *a*	280 *b*	37 *a*	316 *ab*
14	487 *a*	407 *a*	313 *a*	51 *a*	283 *b*
16	496 *a*	430 *a*	331 *a*	37 *a*	283 *b*

* Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 8. Effect of in-row seed spacing on tuber quality of Reveille Russet, 2021.

In-Row Seed Spacing (Inches)	% Growth Cracks	% Knobs	Tuber Specific Gravity
10	2.4 *a**	0.0 *a*	1.084 *a*
12	2.5 *a*	0.0 *a*	1.084 *a*
14	2.9 *a*	0.0 *a*	1.083 *a*
16	3.5 *a*	1.0 *a*	1.085 *a*

* Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 9. Net Returns from Reveille Russet as influenced by plant population (in-row seed spacing) - Total Yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	Total Tuber Yield (cwt/acre)	Gross Income ($10.00/cwt)	Net Returns* ($)
10	34.6	588	509	5090	4,502
12	28.8	490	515	5150	4,660
14	24.7	420	487	4870	4,451
16	21.6	368	496	4960	4,593

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 10. Net returns from Reveille Russet as influenced by plant population (in-row seed spacing) - > 4 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 4 oz Tuber Yield (cwt/acre)	Gross Income ($10.00/cwt) - $	Net Returns* ($)
10	34.6	588	420	4200	3,612
12	28.8	490	414	4140	3,650
14	24.7	420	407	4070	3,651
16	21.6	368	430	4300	3,933

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 11. Net returns from Reveille Russet as influenced by plant population (in-row seed spacing) - > 6 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 6 oz Tuber Yield (cwt/acre)	Gross Income ($11.00/cwt) - $	Net Returns* ($)
10	34.6	588	300	3300	2712
12	28.8	490	280	3080	2590
14	24.7	420	313	3443	3024
16	21.6	368	331	3641	3274

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 12. Net returns from Reveille Russet as influenced by plant population (in-row seed spacing) - > 10 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 10 oz Tuber Yield (cwt/acre)	Gross Income ($12.00/cwt) - $	Net Returns* ($)
10	34.6	588	97	1164	576
12	28.8	490	97	1164	674
14	24.7	420	125	1500	1081
16	21.6	368	146	1752	1385

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

CO11009-3RU:

Tuber Yield and Tuber Size Distribution

Planting potato cultivar CO11009-3RU seed at in-row spacing of 12 inches maximized total tuber yield, and the yield of all tuber size groups evaluated in the study (Table 13). However, in-row seed spacing did not influence the yield of premium size (> 10 oz) tubers.

Tuber Quality

More knobs (2.2%) were observed on tubers when seed of cultivar CO11009-3RU was planted at in-row spacing of 10 inches. Hollow heart was observed in some tubers, but the extent of hollow heart incidence did not differ among in-row seed spacing treatments (Table 14). In-row seed spacing did not impact other tuber qualities evaluated in this study.

Net Returns from cultivar CO11009-3RU as influenced by in-row seed spacing

Maximum net returns was generated for total, marketable size (> 4 oz), and large marketable size (> 6 oz) tuber yield when seed of cultivar CO11009-3RU was planted at in-row seed spacing of 12 inches (Table 15, 16, and 17). For premium size (> 10 oz) tuber yields, the net returns were high when seed was planted at 16 inches within rows (Table 18).

Table 13. Effect of in-row seed spacing on tuber yield and tuber size distribution of cultivar CO11009-3RU, 2021.

In-row seed spacing (inches)	Total	> 4 oz	> 6 oz	> 10 oz	4-10 oz
	Tuber Yield (cwt/acre)				
10	390 *ab**	270 *ab*	174 *ab*	66 *a*	205 *ab*
12	417 *a*	294 *a*	199 *a*	75 *a*	219 *a*
14	369 *b*	252 *b*	152 *b*	62 *a*	191 a*b*
16	384 *b*	270 *ab*	178 *ab*	84 *a*	186 *b*

* Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 14. Effect of in-row seed spacing on tuber quality of cultivar CO11009-3RU, 2021.

In-Row Seed Spacing (Inches)	% Misshapes	% Knobs	% Hollow Heart	Tuber Specific Gravity
10	0.0 *a**	2.2 *a*	2.3 *a*	1.093 *a*
12	0.3 *a*	0.0 *b*	3.7 *a*	1.093 *a*
14	0.0 *a*	0.0 *b*	4.3 *a*	1.094 *a*
16	0.0 *a*	1.0 *b*	1.6 *a*	1.094 *a*

* Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 15. Net Returns from cultivar CO11009-3RU as influenced by plant population (in-row seed spacing) - Total Yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	Total Tuber Yield (cwt/acre)	Gross Income ($10.00/cwt)	Net Returns* ($)
10	34.6	588	390	3900	3312
12	28.8	490	417	4170	3680
14	24.7	420	369	3690	3271
16	21.6	368	384	3840	3473

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 16. Net returns from cultivar CO11009-3RU as influenced by plant population (in-row seed spacing) - > 4 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 4 oz Tuber Yield (cwt/acre)	Gross Income ($10.00/cwt) - $	Net Returns* ($)
10	34.6	588	270	2700	2112
12	28.8	490	294	2940	2450
14	24.7	420	252	2520	2101
16	21.6	368	270	2700	2333

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 17. Net returns from cultivar CO11009-3RU as influenced by plant population (in-row seed spacing) - > 6 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 6 oz Tuber Yield (cwt/acre)	Gross Income ($11.00/cwt) - $	Net Returns* ($)
10	34.6	588	173	1903	1315
12	28.8	490	199	2189	1699
14	24.7	420	152	1672	1253
16	21.6	368	178	1958	1591

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 18. Net returns from cultivar CO11009-3RU as influenced by plant population (in-row seed spacing) - > 10 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 10 oz Tuber Yield (cwt/acre)	Gross Income ($12.00/cwt) - $	Net Returns* ($)
10	34.6	588	66	792	204
12	28.8	490	75	900	410
14	24.7	420	62	744	325
16	21.6	368	84	1008	641

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

CO10085-1RU:

Tuber Yield and Tuber Size Distribution

Total tuber yield and the yield of all other tuber size groups evaluated in this study was maximized when seed of CO10085-1RU was planted at in-row spacing of 12 inches, but these yields did not differ from yields obtained from planting at 10 inches in-row spacing (Table 19). Planting at in-row spacing of 16 inches also maximized total, marketable size (> 4 oz), large marketable size (> 6 oz), and premium size (> 10 oz) tuber yields but reduced the yield of medium size (4-10 oz) tubers significantly (Table 19).

Tuber Quality

In-row seed spacing did not influence tuber external or internal defects. Tuber specific gravity of cultivar CO10085-1RU was not impacted by in-row seed spacing (Table 20).

Net Returns from cultivar CO10085-1RU as influenced by in-row seed spacing

Maximum net returns was generated for total and marketable size (> 4 oz) tuber yields when seed of cultivar CO10085-1RU was planted at in-row spacing of 12 inches. But for large marketable size (> 6 oz) and premium size (> 10 oz) tuber yields, maximum net returns was generated when seed was planted at a spacing of 16 inches within rows (Table 21, 22, 23, and 24).

Table 19. Effect of in-row seed spacing on tuber yield and tuber size distribution of cultivar CO10085-1RU, 2021.

In-row seed spacing (inches)	Total	> 4 oz	> 6 oz	> 10 oz	4-10 oz
	Tuber Yield (cwt/acre)				
10	490 *a**	333 *a*	196 *a*	35 *b*	298 *a*
12	481 *a*	323 *a*	171 *a*	43 *ab*	280 *ab*
14	440 *b*	305 *a*	184 *a*	48 *ab*	257 *bc*
16	463 *ab*	304 *a*	193 *a*	66 *a*	239 *c*

* Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 20. Effect of in-row seed spacing on tuber quality of cultivar CO10085-1RU, 2021.

In-Row Seed Spacing (Inches)	% Growth Cracks	% Hollow Heart	Tuber Specific Gravity
10	0.0 *a**	0.0 *a*	1.088 *a*
12	0.0 a	0.0 *a*	1.087 *a*
14	0.2 *a*	0.0 *a*	1.086 *a*
16	0.0 *a*	0.6 *a*	1.088 *a*

* Figures in the same column and bearing the same letters are not significantly different at the 0.05 level of significance.

Table 21. Net Returns from cultivar CO10085-1RU as influenced by plant population (in-row seed spacing) - Total Yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	Total Tuber Yield (cwt/acre)	Gross Income ($10.00/cwt)	Net Returns* ($)
10	34.6	588	490	4900	4312
12	28.8	490	481	4810	4320
14	24.7	420	440	4400	3981
16	21.6	368	463	4630	4263

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 22. Net returns from cultivar CO10085-1RU as influenced by plant population (in-row seed spacing) - > 4 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 4 oz Tuber Yield (cwt/acre)	Gross Income ($10.00/cwt) - $	Net Returns* ($)
10	34.6	588	333	3330	2742
12	28.8	490	323	3230	2740
14	24.7	420	305	3050	2631
16	21.6	368	304	3040	2673

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 23. Net returns from cultivar CO10085-1RU as influenced by plant population (in-row seed spacing) - > 6 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 6 oz Tuber Yield (cwt/acre)	Gross Income ($11.00/cwt) - $	Net Returns* ($)
10	34.6	588	196	2156	1568
12	28.8	490	171	1881	1391
14	24.7	420	184	2024	1605
16	21.6	368	193	2123	1756

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Table 24. Net returns from cultivar CO10085-1RU as influenced by plant population (in-row seed spacing) - > 10 oz tuber yield, 2021

In-row seed spacing (inches)	Seed Planted (cwt/acre)	Cost of seed planted ($17.00/cwt) - $	> 10 oz Tuber Yield (cwt/acre)	Gross Income ($12.00/cwt) - $	Net Returns* ($)
10	34.6	588	35	420	-168
12	28.8	490	43	516	26
14	24.7	420	48	576	157
16	21.6	368	66	792	425

* Net returns is based on seed cost only. All other costs are assumed to be equal for all treatments and are fixed.

Summary of Plant Population Management Studies:

With row spacings of 34 inches, planting Reveille Russet at in-row spacing of 15 to 16 inches maximizes marketable size tuber yields and generates maximum net returns.
Plant seed of cultivar CO11009-3RU at in-row spacing of 12 inches to maximize tuber yields and net returns.
For potato cultivar CO10085-1RU, plant at in-row spacing of 12 inches to maximize net returns of total and marketable size (> 4 oz.) tuber yields. However, to maximize net returns for > 6 oz and > 10 oz tuber yields, one has to plant cultivar CO10085-1RU at in-row spacing of 16 inches.