Effect of Liquid Phosphorus Fertilizer Blend Application on Potato Tuber Performance and Overall Net Returns

2022 Research Report

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Introduction

With increasing cost of fertilizers, it has become more important than ever to optimize fertilizer application for increased yield and maximum economic returns. Various liquid phosphorus (P) fertilizers are available on the market. However, their agronomic use efficiencies in potato production have not been well documented.

The objective of this project was to evaluate tuber yield and tuber quality response of russet potato to application of blended liquid P fertilizers. The study also investigated economic returns of applying blended liquid P fertilizers as compared to applying 10-34-0 as sole source of P fertilizer.

Experimental Procedure

The field study was laid out as randomized complete block design. Potato cultivar Canela Russet was used in the study. Liquid P fertilizers used in the study and their current prices included, 8-21-5 ($5.25/gallon), 3-18-18 ($8.50/gallon), 9-24-3 ($7.38/gallon), and 8-22-2 ($8.21/gallon). 10-34-0 ($4.79/gallon) is the standard liquid P fertilizer commonly used in Colorado. 10-34-0 is cheaper compared to other liquid P fertilizers and was therefore used as the control P fertilizer treatment in the study.

Treatments consisted of blending 15 lbs of the relatively more expensive liquid P fertilizers with 85 lbs or 68 lbs of the less expensive and standard 10-34-0 P fertilizer. Phosphorus fertilizer treatments consisted of the following, T1=8-21-5/10-34-0 (15/85 lb P/Acre); T2= 8-21-5/10-34-0 (15/68 lb P/Acre); T3= 3-18-18/10-34-0 (15/85 lb P/Acre); T4= 3-18-18/10-34-0 (15/68 lb P/Acre); T5 = 9-24-3/10-34-0 (15/85 lb P/Acre); T6 = 9-24-3/10-34-0 (15/68 lb P/Acre); T7 = 8-22-2/10-34-0 (15/85 lb P/Acre); T8 = 8-22-2/10-34-0 (15/68 lb P/Acre); T9 = Control (10-34-0) – 100 lb P/Acre. Each treatment was replicated four times.

Soil P analysis of the experimental site indicated a residual soil P of 167 lbs P/acre (Mehlich 3). Phosphorus fertilizer was banded. A cost – benefit analysis was conducted to evaluate net returns from the application of each P fertilizer treatment. In calculating net returns, all operational costs were fixed for all treatments, except the cost of P fertilizer which varied for each treatment.

Results

Petiole Phosphorus Concentration

Phosphorus fertilizer blends applied in this study did influence petiole P concentration. In general, P fertilizer blends with 85 lb of 10-34-0 showed higher petiole P concentration compared to the same blend with 68 lbs of 10-34-0 (fig 1). Application of 10-34-0 as sole source of P fertilizer increased petiole P concentration similar to blends with 85 lb of 10-34-0, but higher than blends with 68 lb of 10-34-0. Blending higher rates of 10-34-0 (85 lb P) with other liquid P fertilizers improved P uptake and concentration in the petioles. It should be noted that

petiole P concentration varied for each blend during the growing season. Petiole P concentration declined linearly during the growing season from a high of between 0.28-3.38% to a low of between 0.03-0.05% (fig 1).

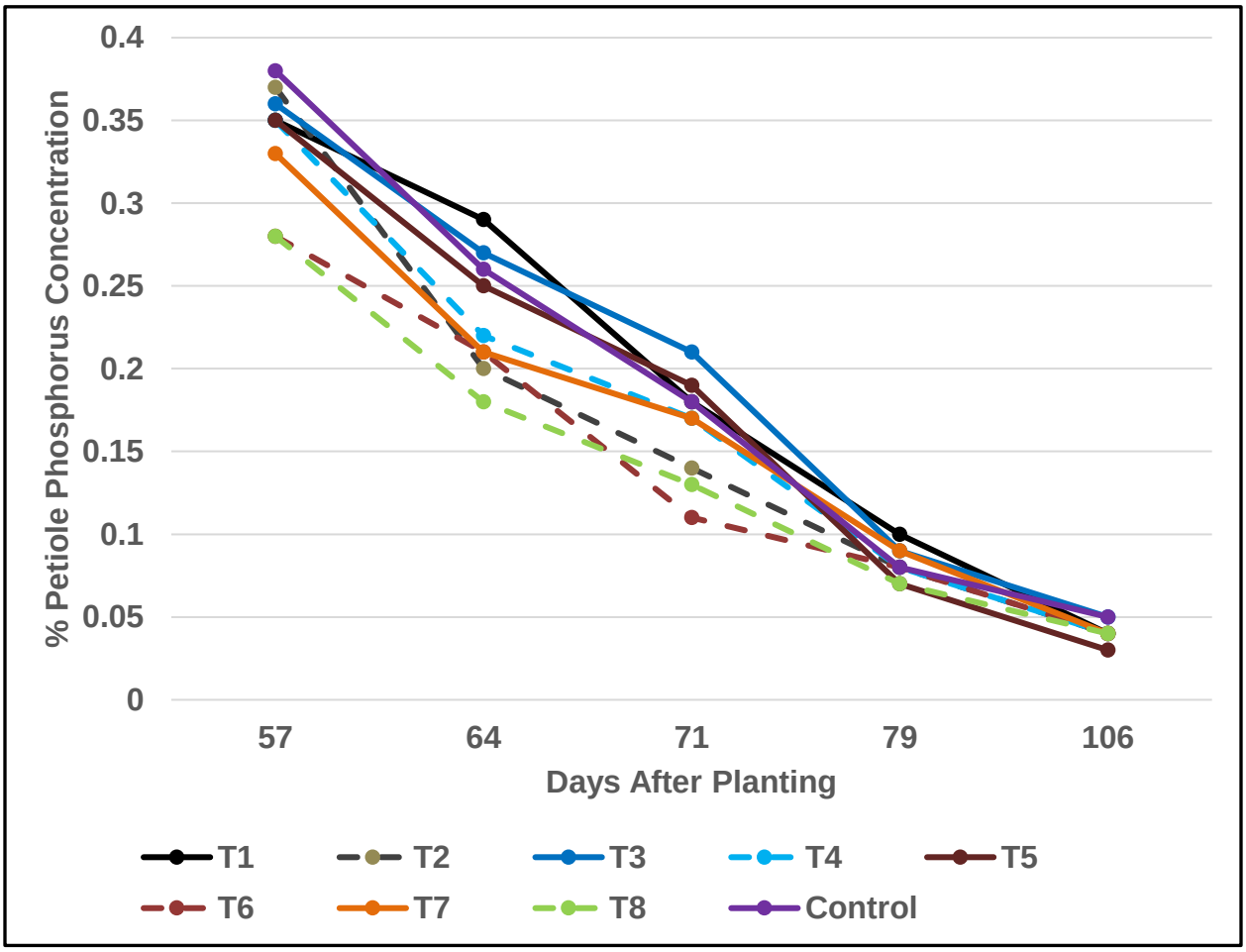

Figure1. Effect of liquid P fertilizer blend application on petiole phosphorus concentration during the growing season, 2022.

Agronomic Phosphorus Use Efficiency (APUE)

Agronomic P Use Efficiency measures the yield of potatoes produced for every pound of P fertilizer applied. For every P fertilizer blend applied in the study, the blend with 68 lb 10-34-0 P/acre used P more efficiently than the blend with 85 lb 10-34-0 P/acre for total and > 4 oz tuber yields (Table 1). Blends with 68 lb 10-34-0 P/acre also used P more efficiently than application of 10-34-0 fertilizer as sole source of P fertilizer.

No difference was observed in P Use Efficiency of > 6 oz. tubers, among blends, or between the application of 10-34-0 as sole source of P fertilizer, with the exception of

15 lb 8-22-2/68 lb 10-34-0 (treatment 8), which had a higher P use efficiency compared to application of 10-34-0 as sole source of P fertilizer; and 15 lb 8-21-5/85 lb 10-34-0 (T1) which had a lower P use efficiency compared to the control treatment (Table 1).

Table 1 Effect of applying liquid phosphorus fertilizer blends on phosphorus use efficiency of Canela Russet, 2022

Treatment	Total Yield	> 4 oz	> 6 oz
	Phosphorus Use Efficiency (cwt/lb P)		
1[y]	3.7 *b*[x]	2.9 *c*	1.8 *c*
2	4.4 *a*	3.6 *ab*	2.3 *abc*
3	3.7 *b*	3.0 *c*	2.2 *abc*
4	4.4 *a*	3.7 *ab*	2.5 a*b*
5	4.0 *b*	3.3 *bc*	2.1 a*bc*
6	4.7 *a*	3.8 *a*	2.4 *ab*
7	3.9 *b*	3.1 *c*	2.1 a*bc*
8	4.5 *a*	3.7 *a*	2.6 *a*
9 (control)	3.7 *b*	2.9 *c*	2.0 *b*

[y] 1 = 15 lb 8-21-5/85 lb 10-34-0; 2 = 15 lb 8-21-5/68 lb 10-34-0; 3 = 15 lb 3-18-18/85 lb 10-34-0
4 = 15 lb 3-18-18/68 lb 10-34-0; 5 = 15 lb 9-24-3/85 lb 10-34-0; 6 = 15 lb 9-24-3/68 lb 10-34-0;
7 = 15 lb 8-22-2/85 lb 10-34-0; 8 = 15 lb 8-22-2/68 lb 10-34-0
9 = 10-34-0 (100 lb P/acre) - control

[x] Figures in the same column and bearing the same letters are not significantly different at 0.05 level of probability.

Tuber Yield and Tuber Size Distribution

With the exception of 8-21-5 blends (T1 and T2), all blended P fertilizers increased yields numerically in all tuber size distribution groups compared to yields obtained from applying 10-34-0 as sole source of P fertilizer (control treatment). Statistically however, different blends were observed to increase yield of different size distribution groups when compared to the control treatment. For example, 15 lb 9-24-3/85 lb 10-34-0 blend (T5) increased total, > 4 oz.,

> 10 oz, and 10-16 oz tuber yield by 10%, 11%, 47%, and 40%, respectively, compared to the control treatment, whereas 15 lb 9-24-3/68 lb 10-34-0 blend (T6) and 15 lb 3-18-18/85 lb 10-34-0 blend (T3) increased 4-16 oz and > 6 oz tuber yield by 10% each, compared to the control treatment (Table 2).

Net Returns from Applying Blended Liquid P Fertilizers

Application of P fertilizer blends influenced net returns from potatoes, when compared to application of 10-34-0 as only source of P fertilizer (control treatment). With the exception of 100 count (4-10 oz) tubers produced by 15 lb 8-21-5/68 lb 10-34-0 (T2), all blends with reduced quantity of 10-34-0 (68 lb/acre) increased net returns of 100, 80, and 60 count potatoes, when compared to the control treatment (Table 3). Net returns from 50 count tubers were high for all blends, except 15 lb 3-18-18/68 lb 10-34-0 (T4) and 15 lb 9-24-3/68 lb 10-34-0 (T6), when compared to the control treatment (Table 3).

15 lb 9-24-3/68 lb 10-34-0 (T6) increased net returns for 100 count (4-10 oz) tubers by 10% and was the highest among all blends for the 4-10 oz. tuber group. 15 lb 9-24-3/85 lb 10-34-0 (T5) increased net returns of 80 count (8-14 oz.), 60 count (10-16 oz), and 50 count (12-19 oz.) tubers by 18%, 42%, and 95%, respectively, when compared to the control treatment (Table 3).

Table 2 Yield response of Russet potato to application of blended phosphorus fertilizers, 2022

Treatment	Total	> 4 oz	4-16 oz	> 6 oz	6-16 oz	> 10 oz	10-16 oz
	Tuber Yield (cwt/acre)						
1[y]	371 *ab*[x]	289 *b*	271 *c*	182 *d*	163 *c*	62 *ab*	43 *b*
2	368 *b*	298 *ab*	290 *abc*	192 *cd*	184 *b*	66 *ab*	58 *ab*
3	369 *ab*	300 *ab*	291 *abc*	217*a*	209 *a*	68 *ab*	59 *ab*
4	368 *b*	307 *ab*	299 *abc*	208 *abc*	201 *ab*	56 *b*	49 *ab*
5	402 *a*	326 *a*	304 *ab*	212 *ab*	190 a*b*	84 *a*	63 *a*
6	387 *ab*	316 *ab*	310 *a*	201 *abc*	195 *ab*	57 *b*	52 *ab*
7	393 a*b*	309 a*b*	297 *abc*	207 a*bc*	196 *ab*	63 *ab*	52 *ab*
8	372 a*b*	309 *ab*	305 *ab*	212 *ab*	208 *a*	51 *b*	48 *ab*
9 (control)	366 *b*	293 *b*	281 *bc*	197 *bcd*	185 *b*	57 *b*	45 *b*

[y] 1 = 15 lb 8-21-5/85 lb 10-34-0; 2 = 15 lb 8-21-5/68 lb 10-34-0; 3 = 15 lb 3-18-18/85 lb 10-34-0; 4 = 15 lb 3-18-18/68 lb 10-34-0

5 = 15 lb 9-24-3/85 lb 10-34-0; 6 = 15 lb 9-24-3/68 lb 10-34-0; 7 = 15 lb 8-22-2/85 lb 10-34-0; 8 = 15 lb 8-22-2/68 lb 10-34-0

9 = 10-34-0 (100 lb P/acre) - control

[x] figures in the same column and bearing the same letters are not significantly different at the 0.05 level of probability

Table 3. Effect of applying blended liquid P fertilizers on net returns when considering P fertilizer cost only, with all other costs fixed, 2022.

Treatment	4-10 oz (100s)	8-14 oz (80s)	10-16 oz (60s)	12-19 oz (50s)
	Net Returns ($/Acre)			
1[y]	4,081.00	1,653.00	997.00	976.00
2	4,175.00	2,092.00	1,414.00	758.00
3	4,129.00	2,185.00	1,394.00	977.00
4	4,501.00	2,136.00	1,150.00	414.00
5	4,333.00	2,321.00	1,518.00	1,102.00
6	4,668.00	2,295.00	1,249.00	513.00
7	4,379.00	1,753.00	1,218.00	827.00
8	4,640.00	2,029.00	1,133.00	715.00
9 (control)	4,227.00	1,972.00	1,067.00	595.00

[y] 1 = 15 lb 8-21-5/85 lb 10-34-0; 2 = 15 lb 8-21-5/68 lb 10-34-0; 3 = 15 lb 3-18-18/85 lb 10-34-0
4 = 15 lb 3-18-18/68 lb 10-34-0; 5 = 15 lb 9-24-3/85 lb 10-34-0; 6 = 15 lb 9-24-3/68 lb 10-34-0;
7 = 15 lb 8-22-2/85 lb 10-34-0; 8 = 15 lb 8-22-2/68 lb 10-34-0;
9 = 10-34-0 (100 lb P/acre) - control

Summary

Data from this study indicate that blending 10-34-0 with other liquid P fertilizers improves P use efficiency, tuber yield and quality, and generates higher economic returns compared to applying 10-34-0 as sole source of P fertilizer in potato production.

It should be noted that the liquid P fertilizers evaluated in this study are unique in their P use efficiencies for different tuber size groups. Potato growers should therefore decide which of the tuber size groups is of importance to their operation, and then decide which P fertilizer blend to use.