# Effects of phosphorus fertilizer rate, timing, and addition of fertilizer enhancer on potato yield and quality Matthew J. Repking and Carrie A.M. Laboski • Department of Soil Science, University of Wisconsin-Madison

#### Abstract

This study was conducted to evaluate the effect of phosphorus (P) rate and timing and the use of Avail® on potato yield and quality. Treatments were applied as either starter fertilizer at rates of 73 and 146 kg P.O. ha-1 with and without Avail® and as sidedress P applied at 73 kg P.O. ha-1. There were 11 locations in Wisconsin (7 coarseand 4 fine-textured soils) in 2006 and 2007. Avail@ was more influential on total yield than rate or timing for 2006. Avail@ increased total tuber yield by 5.21 Mg ha-1 at 6 of 11 locations, although not always statistically significant. There was a significant response to P fertilizer at 1 location, in 2006. In 2007, total yields increased and plateaued as P fertilizer rate increased. Seven locations had a non significant yield increase when 73 kg P<sub>2</sub>O<sub>4</sub> ha<sup>-1</sup> was applied. There was no significant benefit to applying P at sidedress. Specific gravity, a measure of tuber quality, was only significantly affected by P application at one location in 2006.

### Introduction

Potato plants are very inefficient in their ability to use soil phosphorus (P) on some soils (Kelling et al., 1997). The optimum soil test P category for potato is more than three times greater than for other crops (Laboski et al., 2006). Being a high value crop, potato growers generally tend to apply more P fertilizer than recommended because it is inexpensive insurance if a vield response to applied P would occur. State nutrient management regulation requires growers to write and follow a nutrient management plan. This regulation also requires that nutrient application rates should conform to University of Wisconsin Extension (UWEX) guidelines. The potato growers feel that UWEX fertilizer recommendations for P are too low and could potentially reduce potato yield and quality.

Avail® is a relatively new fertilizer enhancing product that claims to improve P availability in the soil when coated on dry or mixed with liquid fertilizers. Avail® is maleicitaconic copolymer, sodium salt with a high cation exchange capacity and it is hypothesized that calcium, iron and aluminum bind to Avail® instead of P, thus allowing P to potentially be more available to plants (Murphy, 2005). Avail@ coated MAP was shown to have some benefit for potato production in the calcareous soils of Idaho (Hopkins et al., 2005).

The objective of the study was to evaluate the effect of P rate and timing and use of Avail® on potato yield and quality

## Materials and Methods

Location	Soil Name†	Taxonomic name	P*	P fert.	pH	OM	and the second second	Y NUMBER	A SECTION.	Contraction of the local division of the loc
	-			rec.‡	1.00		- 188	a the second	0	
			mg kg-1	kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>		g kg-1	1			and the second second
2006		The second second	10.200	1000	95	- 60 T B		Manual Cold	STATES IN COLUMN	Concerne .
н	Plainfield s	Mixed, mesic Typic Udipsamments	62 (L)	146	6.55	12.8	No.	THE R. LEWIS	100	1 Contraction
CF	Sparta Is	Sandy, mixed, mesic Entic Hapuldolls	246 (EH)	34	6.63	15.5	14 191	Sec. Ash		million (P)
WS	Richford Is	Loamy, mixed superactive, mesic Arenic Hapludalfs	186 (EH)	34	5.98	10.8				
S	Mahtomedi Is	Mixed, frigid Typic Udipsamments	35 (VL)	174	6.4	20.0	- 138		S 8 1	120-175
A	Antigo sil	Coarse-loamy over sandy, mixed, superactive, frigid Haplic Glossudalfs	265 (H)	84	5.7	26.0	- Salat	Street, L	10	
тw	Antigo sil	Coarse-loamy over sandy, mixed, superactive, frigid Haplic Glossudalfs	242 (H)	84	5.5	28.0	1124	• 35	2.734	
2007						1000	11 100 1000	1000	A DESCRIPTION OF	100 million
н	Plainfield s	Mixed, mesic Typic Udipsamments	48 (VL)	174	6.82	14.0				
ws	Coloma s	Mixed,mesic Lamellic Udipsamments	152 (H)	84	6.38	14.0				
s	Cress sl	Sandy, mixed, frigid Humic Dystrudepts	90 (VL)	280	6.8	14.0	2 2 MIL Y			
TW1	Antigo sil	Coarse-loamy over sandy, mixed,	140 (L)	213	5.03	31.0	Table 2. T	eatments for all	locations in 20	006 and 2007
		superactive, frigid Haplic Glossudalfs				200	Location	P Source*	P Rate	P Timing
TW2	Antigo sil	Coarse-loamy over sandy, mixed, superactive, frigid Haplic Glossudalfs	180 (O)	101	5.3	28.0	I CONTRACTOR	Contractor	kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>	
+ le loam	veand e eand el	sandy loam; sil, silt loam.				_	2006			
		etation category in parenthesis. L, low; O, optin	um: H bigh: F	H excessively hi	inh		t."	None	0	None
‡ Universi	ity of Wisconsin P f	ertilizer recommendation is based on soil test P				boski et	±	TSP	73	Starter
at. (200	6).						±	TSP	146	Starter
		and the second second			100	ALC: NO	+			
ocatio	ns and treatm	ents								
In 2006,	six locations: H							TSP	218	Starter
TW) and Antigo Airport (A).							-	TSP	291	Starter
• In 2007, five locations: Hancock and Spooner Ag Research Stations (H and S), three grower fields (WS, TW1,								TSP MAP+Avail®	291 73	Starter Starter
TW2).								TSP MAP+Avail© MAP+Avail©	291 73 146	Starter Starter Starter
		ancock and Spooner Ag Research Statio	ons (H and S	), three grower	fields (			TSP MAP+Avail© MAP+Avail© MAP+Avail©	291 73 146 218	Starter Starter Starter Starter
Info reg	arding soil series	A). Iancock and Spooner Ag Research Static and initial soil test levels for each locatic	ons (H and S on can be fou	), three grower	fields (			TSP MAP+Avail© MAP+Avail©	291 73 146	Starter Starter Starter Starter
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protected LSD for rates of TSP and MAP applied as starter. . In 2006 tubers at location H failed to bulk properly due to early blight; thus data may not be representative of normal conditions.

## **Results and Discussion**

## Location: H, WS, TW1 and TW2.

\* Location: S

1.50	1010	-	the set	Grade	1. C. 197	The second	- N
P Source†	P Rate*	Cull	B size	A size	US No. 1	Total	S.G.§
	kg P20, ha-1		1.00	— Mg ha <sup>-1</sup> —	1000		SALL FROM
Location H	1.000	3-6		0000			111
None	0	3.08 ab‡	8.94 c	39.41	13.92	51.43	1.075 b
TSP	73	2.73 bc	11.04 bc	35.76	9.07	49.52	1.075 b
TSP	146	1.84 c	11.73 ab	34.62	9.33	48.19	1.075 b
MAP+Avail®	73	4.15 a	13.26 a	37.82	9.03	55.23	1.079 a
TSP	73s	3.20 ab	9.51 c	38.03	11.61	50.72	1.075 b
P	1.6.	0.011	0.007	0.467	0.163	0.320	0.014
CV,%		24.21	13.01	10.56	28.91	24.21	0.153
Location CF							the second
None	0	8.49 a	3.47	55.80	31.35	67.75	1.074
TSP	73	1.72 b	2.88	65.61	38.65	70.21	1.079
TSP	146	5.44 ab	2.21	63.22	33.14	71.87	1.080
MAP+Avail®	73	5.87 a	4.16	68.96	36.47	78.99	1.079
TSP	73s	8.29 a	3.31	55.27	32.57	66.88	1.077
p		0.016	0.194	0.068	0.493	0.215	0.763
CV,%		42.39	20.78	11.51	18.50	10.38	0.658
Location WS							1000
None	0	9.43	5.25	42.73	31.85	57.41	1.058
TSP	73	12.21	5.63	39.70	30.93	57.53	1.066
TSP	146	11.26	4.94	41.47	32.43	57.67	1.063
MAP+Avail®	73	10.88	7.13	44.70	34.62	62.70	1.071
TSP	73s	9.14	7.29	45.86	35.55	62.29	1.053
р		0.139	0.800	0.647	0.563	0.812	0.115
CV,%		55.83	56.6	14.42	21.14	14.62	0.873
Location S		-	1				24214-1
None	0	18.31	5.07	21.34 d		44.77 c	1.1
TSP	73	22.15	6.22	24.36 cd		52.73 b	99.607
TSP	146	20.69	7.23	28.93 abcd		56.81 ab	- 1
TSP	218	23.75	7.51	27.92 abcd		59.22 ab	
TSP	291	18.17	5.01	33.32 abc		56.48 ab	
MAP+Avail®	146	20.24	5.55	37.58 a		63.36 a	
MAP+Avail®	218	19.27	6.61	36.26 ab		62.13 a	
p	18.00	0.674	0.192	0.018		0.002	100
CV,%		24.44	25.34	21.53		9.24	-
Location A		1.00				-	1000
None	0	3.85	0.74 bc	20.52 c	9.36	25.10	1.075
TSP	73	3.95	0.56 c	25.94 ab	12.42	30.45	1.073
TSP	146	6.69	0.94 ab	24.32 abc	10.23	31.95	1.080
MAP+Avail®	73	2.99	0.98 ab	28.86 a	15.22	32.83	1.079
TSP	73s	3.98	1.12 a	21.57 bc	9.31	26.66	1.074
p		0.298	0.041	0.026	0.065	0.104	0.655
CV,%		55.55	27.10	13.73	25.69	14.67	0.711
Location TW		-					
None	0	2.03	2.70	45.14	18.64	49.87	1.073
TSP	73	4.19	3.21	46.01	18.56	53.42	1.070
TSP	146	2.45	2.67	46.06	16.71	51.19	1.071
MAP+Avail®	73	2.67	3.67	45.87	17.19	52.20	1.074
TSP	73s	3.41	3.65	45.75	19.89	52.81	1.072
p	-	0.389	0.186	0.887	0.599	0.377	0.944
CV.%		54.49	20.95	3.08	16.49	5.02	0.802
						0.02	0.002
TSP, triple sup	erphosphate (0	-46-0); MAP, m	onoammonium	phosphate (11-52 t significantly diffe	erent at the 0.0	5 probability leve	el

Russet Burbank	Table 4. Yield and specific gravity for all locations in 2007.					
<ul> <li>No significant effect of treatment (Table 3) on A size, US No.1, and total yield at H, CF, and WS.</li> </ul>		and the second s	Grade			
A size, US No.1 and total yield for MAP+Avail® were not significantly different than TSP at H, CF, and	P Source†	P Rate*	Cull	B size	A size	US No. 1
WS locations. • At location S, yield increased with P rate and treatments with Avail® had significantly greater yield than	1	kg P205 ha-1			Mg h	a-1
the same rates without Avail®.	Location H	-				
A size, US No.1, and total yield for sidedress P applications were not significantly different than starter	None	0	4.17	6.14	49.43	21.83
<ul> <li>P.</li> <li>No significant difference between rates of starter P fertilizer for A size, US No.1 and total yield at H, CF,</li> </ul>	MAP	73	5.23	5.07	52.64	24.99 25.05
and WS locations	MAP MAP+Avail®	146	4.56	6.34	51.53 52.35	25.05
2007	MAP+Avail®	146	4.46	6.05	53.38	24.97
<ul> <li>No significant effect of treatment (Table 4) on A size, US No.1, and total yield at H, WS, and S.</li> </ul>	MAP	735	3.97	5.77	47.43	21.64
<ul> <li>A size, US No.1, and total yield for sidedress P applications were not significantly different than starter</li> </ul>	MAG	735	0.485	0.656	0.743	0.565
<ul> <li>A size, US No.1, and total yield for MAP+Avail® were not significantly different than MAP.</li> </ul>	CV.%		32.33	18.97	12.04	15.13
CALLER F. M. CO. LER MERINA STRUCTURE IN LA. COMP. THEN	Location WS		02.00	10.57	12.04	10.10
Frito Lay 1867	None	0	2 22	5.80	33.75	8.63
2006	MAP	73	3.39	6.75	37.93	9.89
At TW location, there was no significant difference between treatments with regard to B size and total	MAP	146	4.89	5.91	37.39	11.56
tuber yield.	MAP+Avail@	73	2.72	3.84	37.59	10.92
<ul> <li>At A location, there was a significant difference between treatments for B size yield with greatest yield being sidedress P and no significant difference for total tuber yield.</li> </ul>	MAP+Avail®	146	3.06	6.51	36.71	9.83
B size and total yield for sidedress P applications were not significantly different than starter P at A and	MAP	73s	3.54	4.82	33.75	6.71
TW locations.	P	and the second s	0.409	0.101	0.154	0.263
<ul> <li>B size and total yield for MAP+Avail® were not significantly different than TSP at A and TW locations.</li> </ul>	CV.%		52.96	25.99	16.13	30.01
No significant difference between rates of starter P fertilizer for B size and total yield at A and TW locations	Location S					
2007	None	0	8.31.8	4.72	30.09	107
At TW1 location, there was a significant difference between treatments with regard to B size yield and	MAP	73	8.69.8	4.13	32.63	
218 kg P2O5 ha <sup>-1</sup> MAP+Avail® had the greatest yield.	MAP	146	8.54.8	4.52	30.85	
<ul> <li>Otherwise, at TW1 and TW2 locations, there was no significant difference between treatments with recard to B size and total yield.</li> </ul>	MAP	218	5.13 b	4.87	35.82	
<ul> <li>MAP+Avail® did increase B size tuber yield at locations TW1 and TW2, although not always significant.</li> </ul>	MAP+Avail®	73	7.31 ab	3.99	32.63	
No significant difference between rates of starter P fertilizer for B size and total yield at TW1 and TW2	MAP+Avail®	146	6.67 ab	4.43	31.52	1000
locations.	MAP+Avail@	218	4.67 b	5.43	34.12	
<ul> <li>Increasing P rates did not significantly increase yield at TW1 and TW2.</li> </ul>	P	-	0.044	0.689	0.703	
and the second sec	CV.%	1.20	27.83	26.19	15.20	
Fertilizer rates vs. fertilizer recommendations	Location TW1	1.5 400	1000			1000
University of Wisconsin P fertilizer recommendations are based on total yield goal and always resulted	None	0	1.89	4.80 ab	34.10	7.98
in an over application of P compared to the rate needed to maximize yield.	MAP	73	1.56	4.24 b	38.36	10.34
•11 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> at two locations.	MAP	146	2.08	4.32 b	39.88	9.13
<ul> <li>15-35 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> at four locations.</li> <li>100-280 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> at five locations.</li> </ul>	MAP	218	1.42	4.54 b	38.00	8.15
	MAP+Avail®	73	1.57	4.72 b	37.60	7.00
<ul> <li>Russet Burbanks average change in yield for the 73 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> rate compared to control:</li> <li>All seven locations: total and A size tuber yield change was 2.09 and 1.76 Mg ha<sup>-1</sup>, respectively.</li> </ul>	MAP+Avail@	146	1.81	4.63 b	39.49	8.71
<ul> <li>Four of seven locations had a yield increase, although not always significant: total and A size tuber</li> </ul>	MAP+Avail@	218	1.75	5.58 a	37.71	7.58
yield change was 4.14 and 5.06 Mg ha <sup>-1</sup> , respectively.	P		0.899	0.048	0.448	0.756
<ul> <li>Russet Burbanks are paid on A size tuber yield, this would result in an additional \$387 ha-1 for all</li> </ul>	CV,%	1000	43.83	12.08	9.89	34.89
locations and \$1113 ha <sup>-1</sup> for responsive locations, while 73 kg P <sub>2</sub> O <sub>5</sub> MAP cost \$54.04 ha <sup>-1</sup> . • Russet Burbanks average change in yield for the 146 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> rate compared to 73 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> :	Location TW2		2.54		39.56	8.25
<ul> <li>All seven locations: total and A size tuber yield change was 0.21 and -0.09 Mg ha<sup>-1</sup>, respectively.</li> </ul>	None	0	2.54	4.39		
<ul> <li>Two of seven locations with yield increase, although not always significant: total and A size tuber</li> </ul>	MAP	73 146	2.65	4.74	41.43 43.02	9.30 12.00
yield was 2.85 and 4.14 Mg ha-1, respectively. The increased yield included one location with very	MAP	218	2.27	5.11	43.02	9.04
low soil test and one with an excessively high soil test P level.	MAP+Avail®	218	2.67	5.05	42.69	9.04
<ul> <li>Frito Lay 1867 average change in yield for the 73 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> rate compared to control:</li> <li>All four locations: total and B size tuber yield change was 3.65 and 0.03 Mg ha<sup>-1</sup>, respectively.</li> </ul>	MAP+Avail®	146	1.97	4.93	40.07	10.55
<ul> <li>This suggests that for silt loam soils when soil test P is &gt;140 ppm there is likely no response to</li> </ul>	MAP+Avail®	218	1.88	6.03	44.80	11.75
additional fertilizer for B size tubers.	P		0.486	0.052	0.098	0.115
Conclusions			31.53	12.79	5.58	5.58
onnations.	CV,% † TSP, triple sup	perphosphate (0-4	6-0); MAP, m	nonoammoniu	m phosphate (1	1-52-0).
•Fertilizer recommendations are more than adequate for potato growers in Wisconsin, at all locations	Values within e     's, sidedress,	each column follo	wed by the sa	ame letter are	not significantly	different at the 0.0
total yield plateued before the fertilizer recommendation was reached.	*s, sidedress. § S.G., specific (	gravity				
•Rates of starter P may not have been statistically different but economically adding 73 kg P2O5 ha-1 had			-		-	
a return of \$333.13-\$1059.16 ha <sup>-1</sup> for Russet Burbanks, but this increase may have been attained at a					1	
lower rate.						
•73 kg P2O5 ha-1 effected B size and total yield of Frito Lay 1867 differently, thus growers need to define and other than the size and total yield of Frito Lay 1867 differently, thus growers need to define						
marketing objectives to justify economical fertilizer P application rates.	References		Que 1 7 7		0.0	
•Growers tend to apply 146-219 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> , large P applications are unnecessary based on this	Hopkins, B.G., J.	w. ellsworth, J.C	Stark, I.R. I	sowen, and A	G. Cook. 2006	5. How to improve f

ers tend to apply 146-219 kg P<sub>2</sub>O<sub>4</sub> ha<sup>-1</sup>, large P applications are un research and increase the potential for P loss and reduce profitability. Thus, convincing growers to apply lower rates would be an improvement over current practices.

 Avail® increased total tuber yield by 5.21 Mg ha<sup>-1</sup> at 6 of 11 locations, although not always statistically significant.

There was no significant benefit to applying P at sidedress to make it more available to the plant later in the growing season.

#### rtilizer P recovery Fertigation, Soil Sci, Soc, Am, Annual Meetings, 6-10 November, 2005 Salt Lake City, UT, Kelling, KA. and P.E. Speth. 1997. Influence of Phosphorus Rate and Timing on Wisconsin Potatoes. Proc. 1997

S.G.8

0.976 869.0

0.299 9.73

59.74 1.080

62.94 1.081

62.43 1.082

62.35 1.080

62.77 1.080

57.17 1.080

41.77 1.079 48.07 1.082

48.19 1.083 44.14 1.082 46.28 1.086 36 20 1.080 0.079 0.127 14.48 0.274

43 12 45.44 43.09 45.18 43.92 42.72 44.21 0.936 9.57 40 78 1.094

44.15 1.091

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43.91 1.093 43.89 1.094 45.94 1.095

44.97 1.093 0.462 0.485

8 32 0 251

46,49 1.091

48.82 1.094

49.65 1.088

50.08 1.092

48.29 1.096 49.15 1.091

52.71 1.088

0.078

5.05 0.369

05 probability level.

0.083

Wis Potato Meetings 10:33-41 Laboski, C.A.M., J.B. Peters, and L.G. Bundy. 2006. Nutrient application guidelines for field, vegetable, and fruit crops in Wisconsin. Univ. of Wisconsin Extension Publication A2809.

Murphy, L. 2005. How to improve fertilizer P recovery: Coating and P products. Soil Sci. Soc. Am. Annual Meeting 6-10 November, 2005 Salt Lake City, UT.