USE OF POST-HARVEST APPLIED PHOSPHOROUS ACID FOR CONTROL OF POTATO STORAGE DISEASES

LYNN WOODELL[1], NORA OLSEN[1], JEFF MILLER[2], PHILLIP B. HAMM[3]

[1]UNIVERSITY OF IDAHO, KIMBERLY, IDAHO, USA

[2]MILLER RESEARCH, RUPERT, IDAHO, USA

[3] OREGON STATE UNIVERSITY, HERMISTON, OREGON, USA


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University of Idaho
Potato Storage Research

- Built in 1991
- 9 computerized bins- 2000 cwt each
- Independent controlled environments
- Easy manipulation of temperature, airflow and humidity

INTRODUCTION


Double L
978

INTRODUCTION

Miller Research LLC

PHOSPHOROUS ACID (PA)

- Phosphorous Acid is H_3PO_3
  - Also referred to as Phosphites, phosphonates, salts of phosphorous acid, phosphonic acid
    - FRAC group 33 (low risk of resistance)
  - Mono- and di-basic Na, K, and ammonium salts of phosphite
- PA not considered a good source of P nutrition for potatoes
- Can trigger a natural defense reaction in plants

OBJECTIVE

The objective of these studies over 15 years was to evaluate the efficacy of phosphorous acid products as a post-harvest spray to control multiple pathogens causing common storage diseases.

Pathogens included Phytophthora infestans (late blight), *Phytophthora erythroseptica* (pink rot), *Helminthosporium solani* (silver scurf) on naturally infected tubers in storage, *Fusarium sambucinum* (dry rot) and Pythium ultimum (leak).

ADDITIONAL STUDIES

- Refined inoculation methods
- Determined treatment rate, volume and timing
- Tuber fry quality
- Induce tuber phytotoxicity
- Early studies on late blight US8 later US23
- Multiple cultivars
- Other diseases

MATERIALS AND METHODS

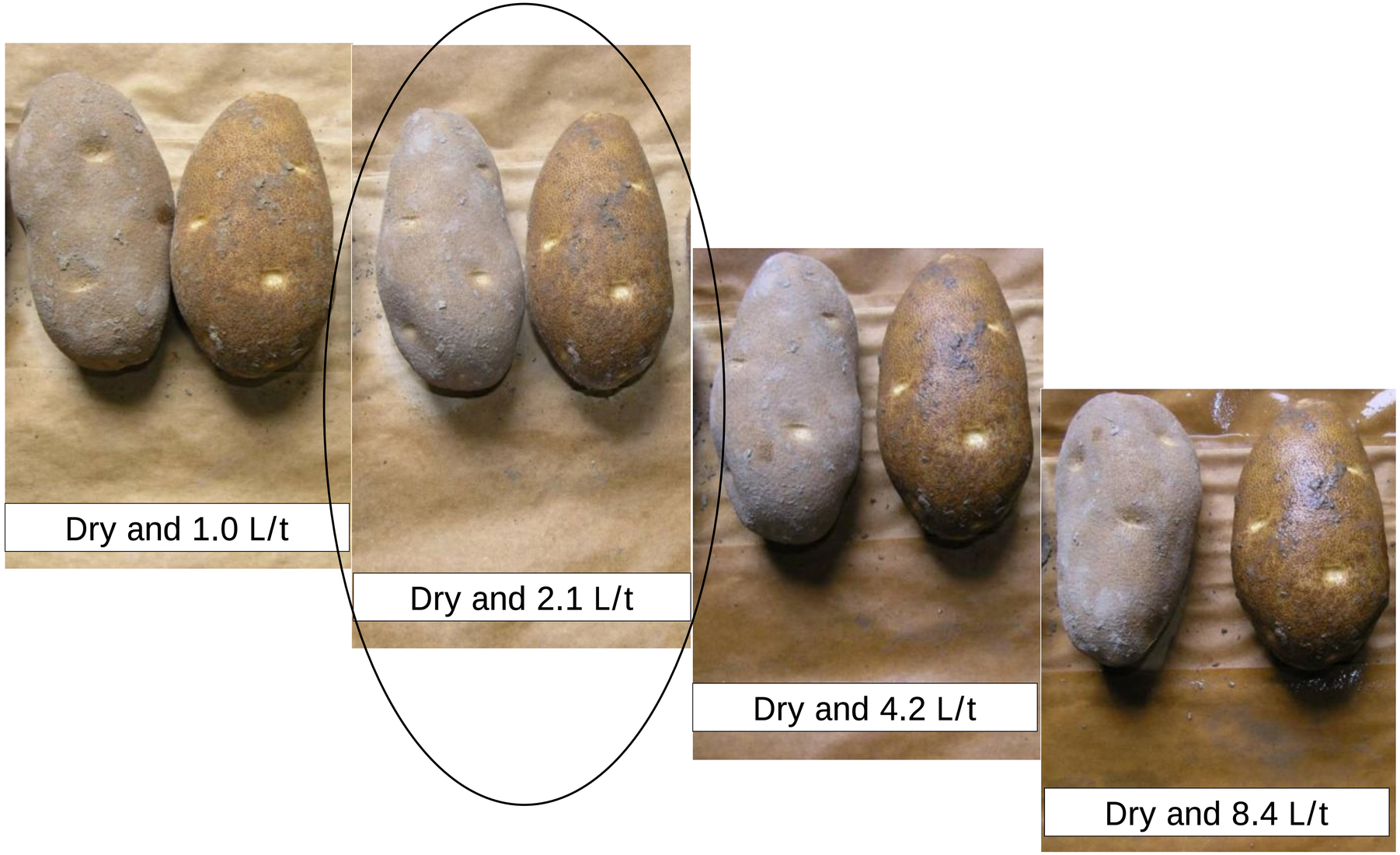
Procedures	Late blight	Pink rot	Silver scurf	Dry rot	Pythium leak
Tuber prep	-	Wound	Mother tuber infected. Daughter tubers harvested.	Open wound	Tumble 1 minute
Inoculation	Submerge Spray table	Submerge Tumble and spray	Natural field	Spray table	Tumble and spray
Set Time	30-60 minutes	30-60 minutes	Not applicable	30-45 minutes	30-45 minutes
Treatment	Spray cabinet or table	Spray cabinet or table	Spray cabinet or table	Spray table	Spray table
Storage	3 weeks	2 weeks*	3- 6 months	3-5 months	4 days*
Evaluation	Peel Incidence(%) Surface area infected(%)	Longitudinal halves Incidence(%) Severity	Rating scale1-4 Incidence(%) Severity	Longitudinal quarters Incidence(%) Severity	Longitudinal halves, Incidence(%)

INOCULATION

TREATMENT

STORAGE

POST-HARVEST SPRAY APPLICATION VOLUMES



EVALUATIONS

- Late blight

- Pink rot

- Silver scurf

- Dry Rot

- Pythium leak

RESULTS

Efficacy on
Pink rot

Efficacy on
Late blight

EFFECTS OF ZOXAMIDE AND PHOSPHOROUS ACID ON PINK ROT

Treatment	Rate, L/t	Incidence[1]	Severity
Untreated	-	88 a	82 a
HPPA	0.08	57 b	53 a
Zoxamide	x	36 bc	30 ab
Zoxamide	2x	21 cd	18 b
Zoxamide	4x	7 ef	5 cd
Zoxamide	8x	11 def	4 cd
Zoxamide	16x	16 de	7 c
PA	0.42	7 f	2 d

[1]Means with the same letter within a column are not significantly different at $p \leq 0.05$

EFFECTS OF ZOXAMIDE AND PHOSPHOROUS ACID ON LATE BLIGHT

Treatment	Rate, L/t	Incidence[1]	Severity
Untreated	-	64 a	24 a
HPPA	0.08	44 a	15 b
Zoxamide	4x	0 c	0 c
Zoxamide	8x	0 c	0 c
Zoxamide	16x	0 c	0 c
PA	0.42	1 b	1 c

Miller, J.S., Olsen, N., Woodell, L., Porter, L.D., and Clayson, S.2006.Post-harvest applications of zoxamide and phosphite for control of potato tuber rots caused by oomycetes at harvest.Am. J. Potato Res. 83:269-278.

[1]Means with the same letter within a column are not significantly different at $p \leq 0.05$

EFFICACY OF PHOSPHOROUS ACID ON PINK ROT USING WASHED AND UNWASHED TUBERS

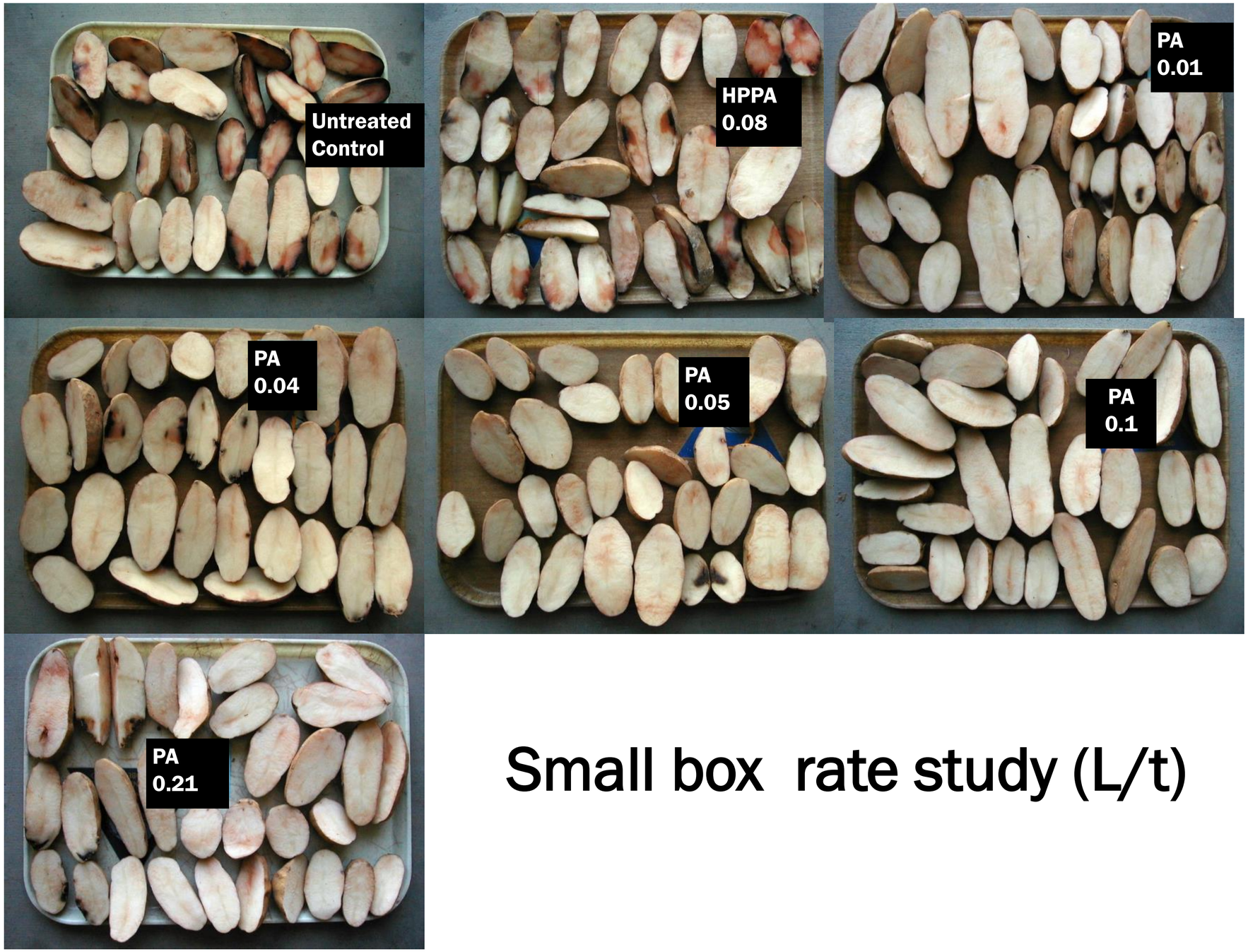
Treatment (L/ton tubers)[1]	Incidence*	Severity**
UTC washed	84.8 a	62.8 a
UTC unwashed	79.9 a	57.9 a
PA (0.1) washed	0.0 b	0.0 b
PA (0.1) unwashed	0.1 b	8.8 b

[1]Values in the same column followed by the same letter are not significantly different.
*Percentage of inoculated tubers developing symptoms of disease.
**Average tuber area affected. Only tubers showing symptoms of disease were used for this assessment (healthy tubers not included).

EFFECT OF PHOSPHOROUS ACID RATE ON PINK ROT

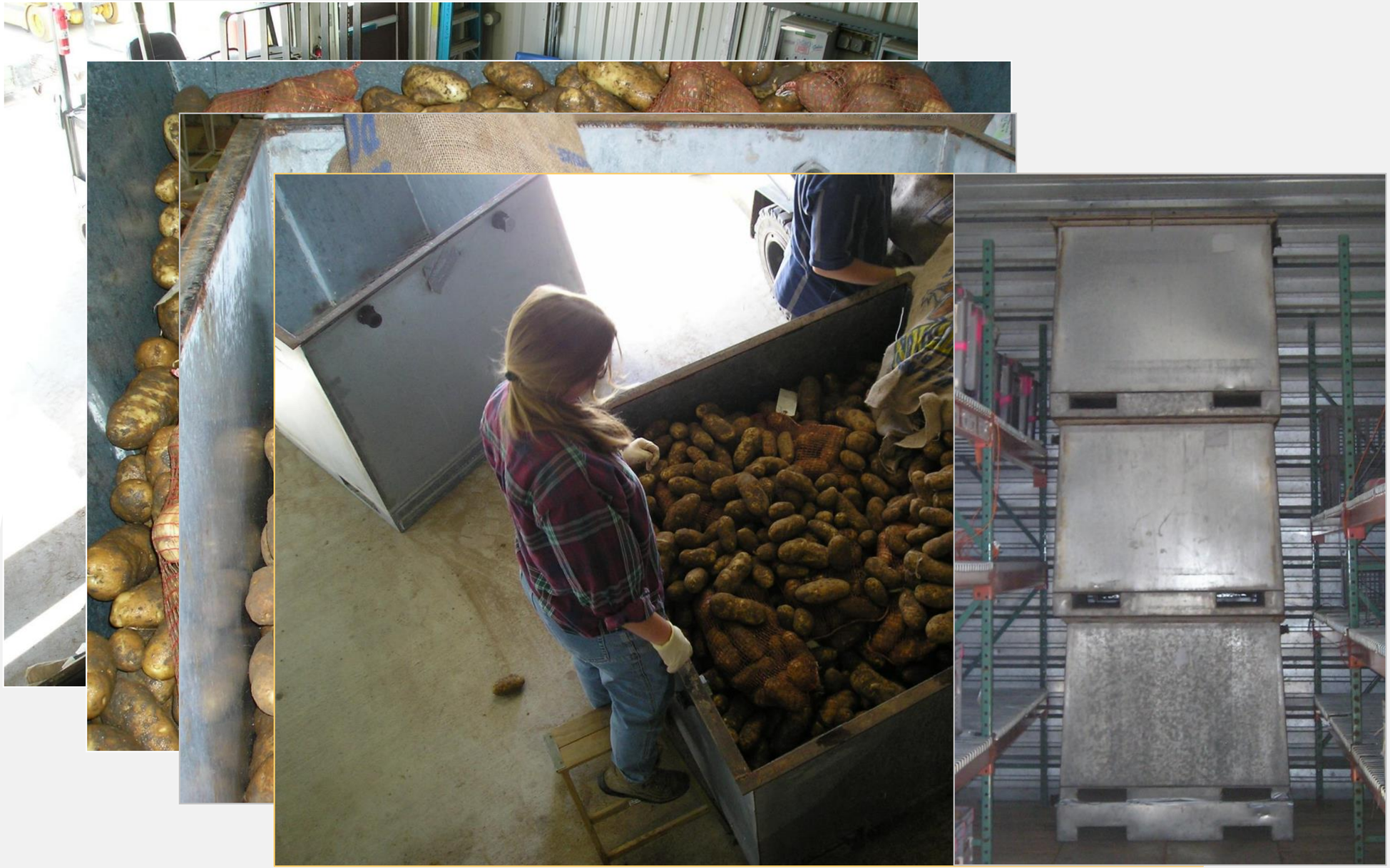
Treatment	Rate, L/t	% Incidence[1]	Severity
Untreated	-	85 a	63 a
HPPA	0.08	75 a	35 b
PA	0.01	26 b	13 c
PA	0.02	20 bc	9 cd
PA	0.05	8 bc	9 cd
PA	0.10	0 c	0 d
PA	0.21	5 bc	3 d

[1]Means with the same letter within a column are not significantly different at p≤0.05



Small box rate study (L/t)

TREATMENT PLACEMENT IN TONNE BOXES



PINK ROT INFECTION AFTER 77 DAYS IN TONNE BOX STORAGE

Rep 1

Rep 2

Rep 3

Rep 4

UTC | HPPA | PA 0.05 L/t | PA 0.10 L/t | PA 0.42 L/t

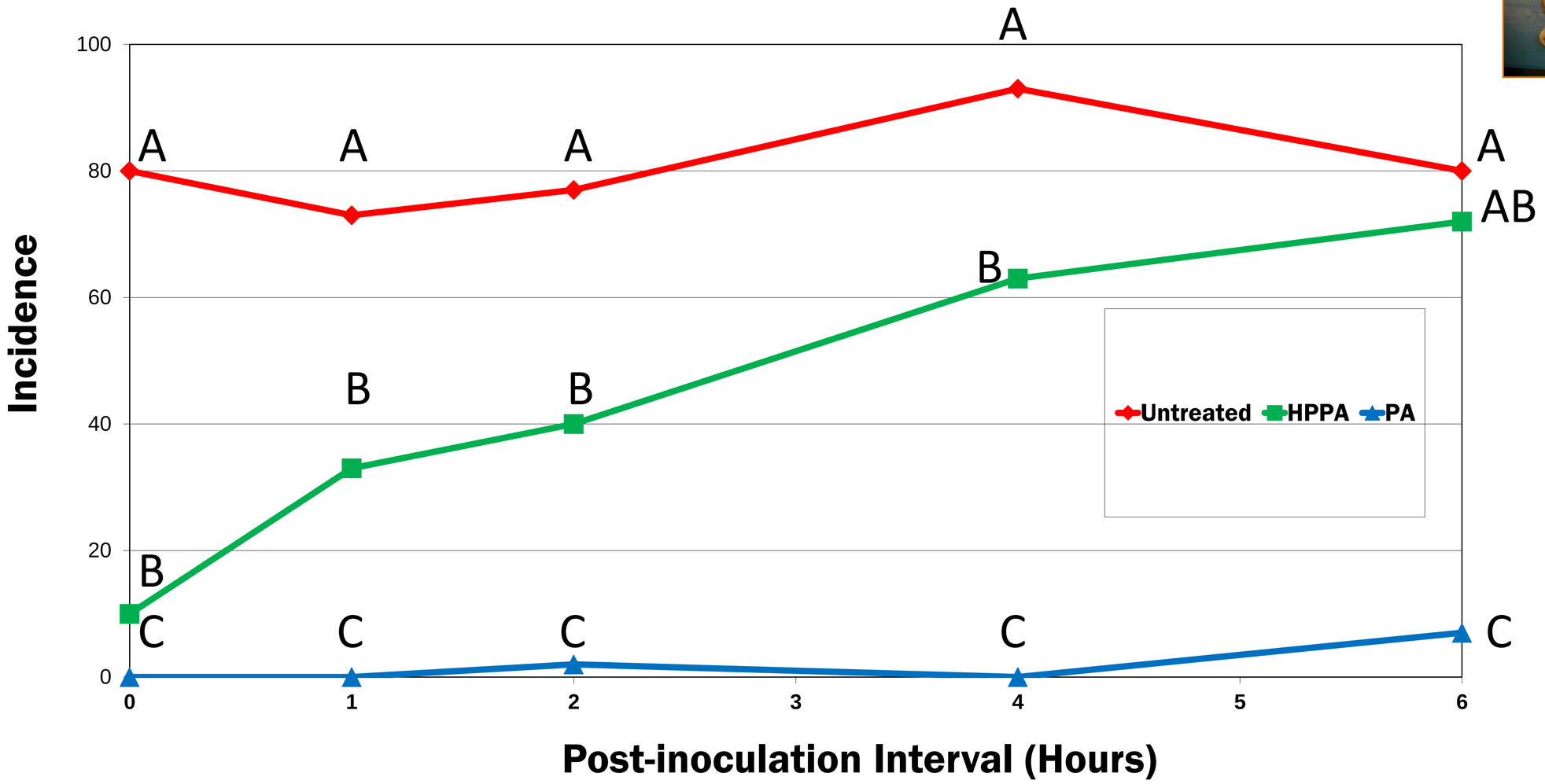
LATE BLIGHT INFECTION AFTER 77 DAYS IN TON BOX STORAGE

Rep 1

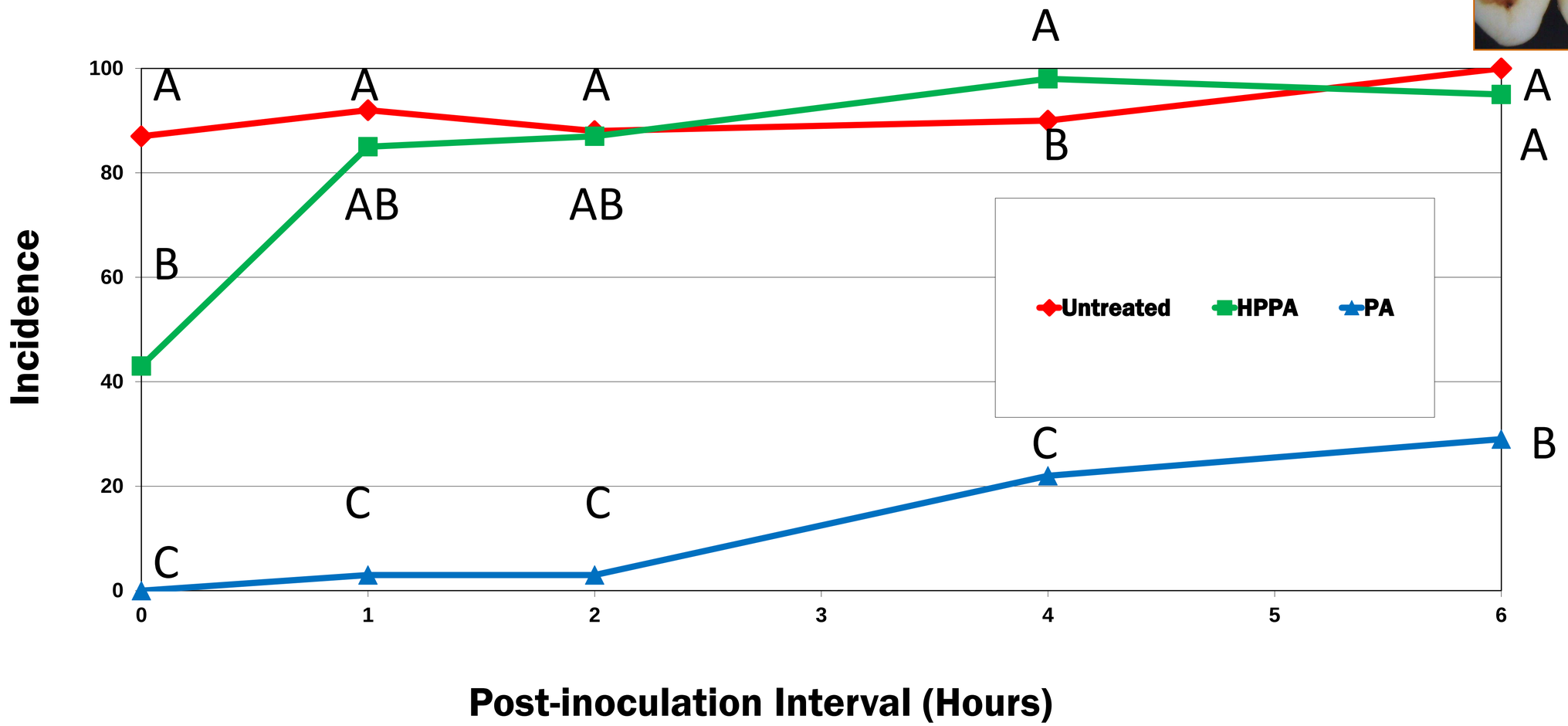
Rep 2

UTC	HPPA 0.08 L/t	PA 0.05 L/t	PA 0.10 L/t	PA 0.42 L/t

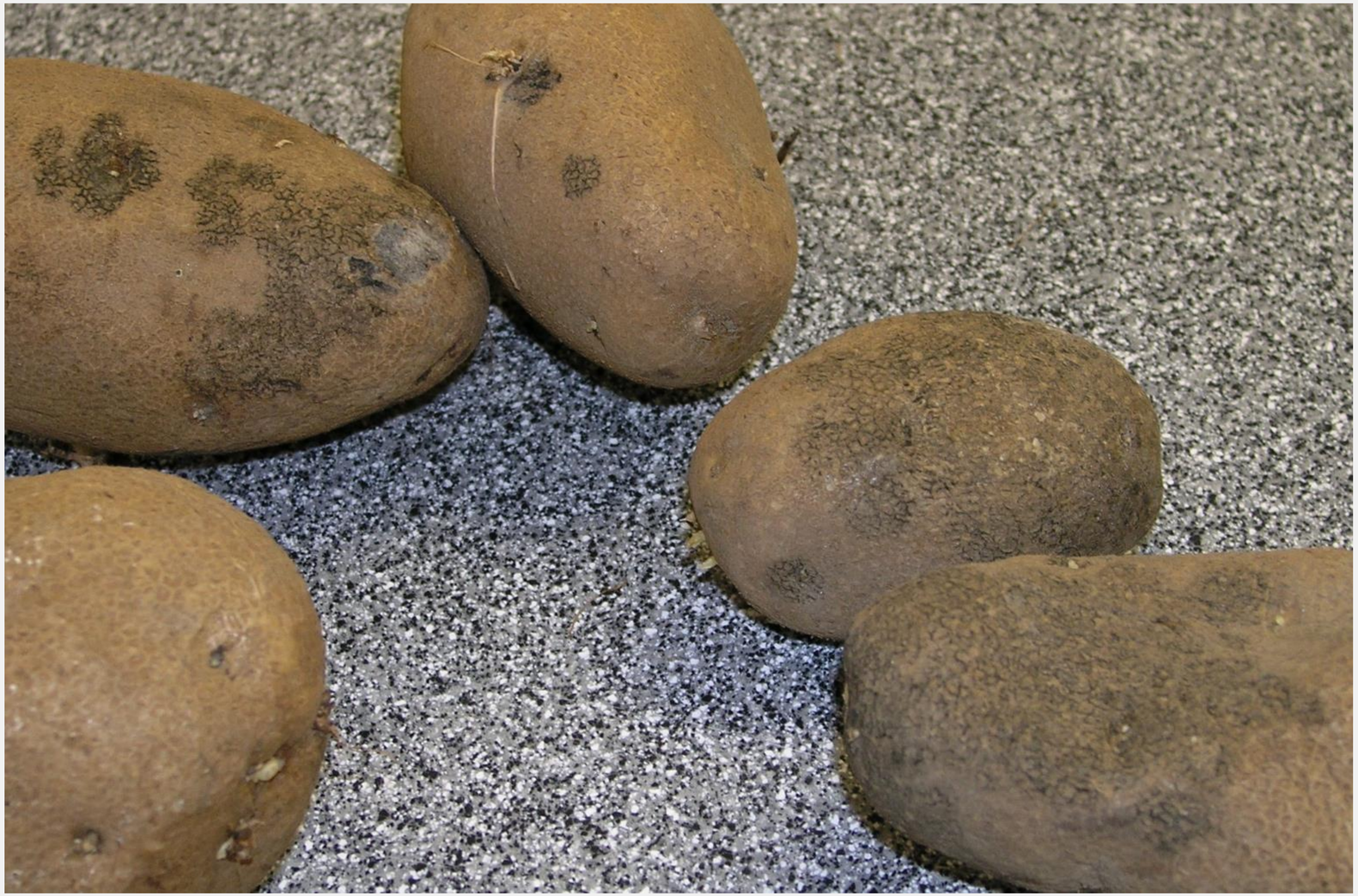
EFFECT OF POST-INOCULATION INTERVAL ON INCIDENCE OF LATE BLIGHT



EFFECT OF POST-INOCULATION INTERVAL ON INCIDENCE OF PINK ROT



RESULTS ON SILVER SCURF



PHOSPHOROUS ACID ON SILVER SCURF

Incidence (%) of silver scurf				
	~3 months in storage		~6 months in storage	
Year	Water-treated control	Phosphorous Acid	Water-treated control	Phosphorous Acid
2010	77	40	75	60
2011	32	5	19	3
2013	67	7	31	5
average	**45**	**13**	**30**	**16**

- Efficacy when used as a seed treatment with and without a post harvest spray
- Efficacy when used as a foliar treatment, post harvest spray and both at 3 different rates and 3 volumes

SILVER SCURF CONCLUSIONS

- Using a phosphorous acid product can reduce silver scurf incidence and severity
- Label rate is effective. Lowering may cause less consistent results.
- Applying higher volume could increase free moisture that can produce favorable conditions for other diseases. Lower volumes may not be adequate for commercial application with high volumes of potatoes being treated.
- Importance of an overall silver scurf reduction program that includes seed and field component to decrease the level at harvest and in-storage.

PHOSPHOROUS ACID EFFICACY ON OTHER DISEASES

Incidence (%) of Dry rot		
	~3 months in storage	
Year	Water-treated control	Phosphorous Acid
2006	29	28
2007	50	59
2008	47	57
2009	64	75
2010	35	36
2011	29	31
2012	80	71
average	**48**	**50**

Incidence (%) of Pythium		
	4 days in storage	
Year	Not-treated control	Phosphorous Acid
2011	46	40
2012	50	52
2013	22	18
2016	13	16
2017	49	47
average	**36**	**35**

EFFECT OF PHOSPHOROUS ACID ON TUBER PROCESSING QUALITY

Russet Burbank stored 158 days after treatment

Quality[1]	Untreated Control	Phosphorous acid
Glucose (%fwt)	0.035 a	0.033 a
Sucrose (%fwt)	0.103 a	0.097 a
Mean fry color[2]	48.0 a	50.0 a

[1]Values in the same row followed by the same letter are not significantly different.
[2]USDA fry color rating #1≥ 44, #2 < 44 but ≥ 35, #3 = < 35 but ≥26 reflectance

PHOSPHOROUS ACID ON SEED

SEED LOTS TREATED WITH LABEL RATE AND 2X RATE

	Russet Burbank	Russet Norkotah	Dark Red Norland
Sprout rating	**NS**	**NS**	**NS**
Sprout wt	**NS**	**2x rate- lower**	**NS**
Enlarged lenticels	**NS**	**NS**	**NS**
Pitting	**NS**	**NS**	**NS**
Emergence	**NS**	**NS**	**-**
Stem #/plant	**NS**	**NS**	**-**
Specific Gravity	**NS**	**NS**	**-**
Total,US1,US2, culls yield	**NS**	**NS**	**-**
Size categories	**NS**	**2x rate more 312-354g size**	**-**

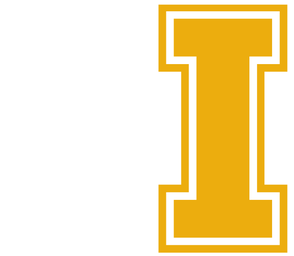
CONCLUSION

Phosphorous Acid post-harvest spray applications:

- **do not offer significant dry rot or leak control**
- **provide reduction of late blight, pink rot and silver scurf disease development**
- **should be considered as a tool in a post-harvest disease control program**

Acknowledgements

- Idaho Potato Commission
- Northwest Potato Research Consortium
- Chemical Companies for funding and/or product



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