FACTORS AFFECTING TRANSMISSION OF LATE BLIGHT FROM SEED PIECE TO SPROUT

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Transmission of the late blight pathogen from the seed piece to the sprout and the subsequent establishment of the disease within a planting is likely a function of several factors including, 1) amount of inoculum, 2) cultivar susceptibility, 3) condition of the seed at planting, 4) time frame between seed cutting, fungicide treatment and planting, and 5) environmental conditions during emergence. If we are to be successful in managing the seedborne phase of this disease, it is important to improve our understanding of factors that contribute to the transmission of the pathogen from the seed piece to the sprout. The first four factors are discussed below.

This year in studies at Mount Vernon and Corvallis, we observed that transmission of the late blight fungus from the seed piece to the sprout occurred when the density of the pathogen on the cut seed piece was low (<200/seed piece). At higher inoculum densities the seed pieces failed to emerge because of rapid decay by the soft rot bacteria. This suggests that transmission on cut seed pieces is a function of amount of inoculum. We also found that transmission was higher for cv. Shepody and Russet Norkotah compared to Russet Burbank, Kennebec and Bzura.

In studies with Russet Burbank concerning condition of the seed at planting, we learned the following. First (Table 1 a & b), with an increase in sprout length there was a significant increase in stand establishment as measured by area under the emergence progress curve (AUEPC). Transmission of *Phytophthora infestans* was observed in two instances, both times when sprouts of intermediate length on seed pieces were inoculated (20 sporangia/seed piece) with US-11 in Washington but not with US-8 in Oregon. Second (Table 2 a & b), with physiologically older seed there was a decrease in stand establishment as measured by AUEPC at the low inoculum density (20 sporangia/seed piece); at the high density (2000 sporangia/ seed piece) 100% of the seed pieces decayed and the stand was compromised. Furthermore, significantly more aged than non-aged seed pieces decayed at the low density. Transmission of the pathogen was not detected in either the Mount Vernon or Corvallis experiments.

The time frame between inoculation, seed cutting and fungicide treatment also influences stand and perhaps even transmission success. Last year we showed that when seed piece treatments with activity against *P. infestans* (Tops-Mancozeb, Curzate M-8, Mancozeb) were applied <u>protectively</u> (prior to inoculation with *P. infestans*) to seed pieces of White Rose or Russet Burbank, emergence and stand establishment were similar to the fungicide-treated non-inoculated (healthy) control. In contrast, fungicides applied <u>curatively</u> to seed pieces (7 days following inoculation of the mother seed tubers) did not improve emergence or stand establishment. Inoculum density was 2000 sporangia/seed piece. This year, when whole tubers were inoculated with low inoculum density (200 sporangia/seed piece), Tops-Mancozeb performed better than Tops 5D or the nontreated control for percent emergence and AUEPC at 0.5 and 1.5 days incubation before seed cutting but not at 3 or 7 days incubation before seed cutting. Incubation time x seed treatment interaction was significant for percent emergence, AUEPC and aerial biomass (Table 3). Transmission was suspected but could not be confirmed due to a severe foliar epidemic in the trial when sprouts emerged in late June. The data from this preliminary experiment suggest that timing of seed piece treatment is critical, not only to protect seed pieces during the seed cutting operation but to protect tubers exposed to inoculum of the fungus during seed handling.

Finally, control of transmission of late blight is of utmost importance to growers. Over the last two years, our studies have consistently shown that Tops-Mancozeb has activity against seedborne *P. infestans* whereas Tops 5D does not, and that Tops-Mancozeb should be used as a protective rather than a curative seed piece treatment. This year, the efficacy of seed piece fungicides, under conditions favorable for transmission, was evaluated for control of *P. infestans* at WSU-Mount Vernon. Fungicides were applied preventively at the time of inoculation, and the inoculum dose of US-11 *P. infestans* was intermediate (1000 sporangia/seed piece).

All fungicide treatments (Table 4) performed significantly *(P=0.05)* better than the inoculated nontreated control for percent emergence, area under emergence progress curve (AUEPC), fresh weight, tuber yield and percent healthy seed pieces. AUEPC values were statistically the same for the two non-inoculated treatments and the inoculated Tops-Mancozeb treatment. Inoculated Tops-Mancozeb and non-inoculated Tops-Mancozeb treatments were not significantly different for any variable. Tops-Mancozeb had a significantly higher AUEPC value than Seed Treatment for Potatoes (Maneb+Streptomycin Sulfate), but final emergence was significantly lower compared to LS214. There were no significant differences among inoculated fungicide treatments for fresh weight or tuber weight. Tops-Mancozeb, LS 214 (Gustafson experimental material) and Tops-Mancozeb-Curzate had a significantly higher percentage of healthy seed pieces compared to Mancozeb-Curzate. Currently, *P. infestans* US-8 is the predominant genotype of potato in northwestern Washington. However, extracts of spores from lesions on the inoculated nontreated control plant where transmission was evident were made a few days after emergence; allozyme banding patterns were positive for *P. infestans* US-11, indicating that transmission of the fungus from the inoculated seed piece to sprout had occurred.

Table 1a. Effect of sprout length across inoculum of US-11 *P. infestans.**

	Washington (US-11)				Oregon (US-8)			
Sprout length	% Emergence	AUEPC	Aerial biomass (g dry wt.)	% Soft rot	% Emergence	AUEPC	Aerial biomass (g dry wt.)	% Soft rot
Long	100	2037 a	200	6	99.5	1231 a	15.8	---
Short	98	1529 b	180	4	97.8	1065 b	14.4	---
Not sprouted	95	837 c	163	4	100	758 c	13.5	---
LSD (P=0.05)	NSD	112.87	NSD	-----	NSD	101	NSD	---

Table 1b. Effect of inoculation with US-11 *P. infestans* across sprout length*.

P. infestans	% Emergence	AUEPC	Aerial biomass (g dry wt.)	% Soft rot	% Emergence	AUEPC	Aerial biomass (g dry wt.)	% Soft rot
Not inoculated	98	1504	179	4	99.5	1032	15.1	---
Inoculated	98	1432	185	5	98.7	1004	14.1	---
LSD (P=0.05)	NSD	NSD	NSD	-----	NSD	NSD	NSD	---

*No transmission detected in OR, but on two plants in WA in inoculated/short sprout treatment.

Table 2a. Washington physiological age experiment (US-11 *P. infestans*).*

	% Emergence			AUEPC			% Soft rot			Aerial biomass (g dry wt.)		
Inoc. density	0	Low	High	0	Low	High	0	Low	High	0	Low	High
Tuber age												
Normal	98	78 a	2	565 b	550 a	17	0	30 a	100	3.0	3.0 a	0
Intmd	100	54 b	0	681 a	397 ab	0	0	64 b	100	4.1	1.4 b	0
Old	100	40 b	0	676 a	301 b	0	0	78 b	100	4.3	1.1 b	0
LSD (P=.05)	NSD	20.2	NSD	78.8	162.9	NSD	NSD	19.2	NSD	NSD	1.1	NSD

Table 2b. Oregon physiological age experiment (US-8 *P. infestans*).*

Inoculum density	% Emergence	AUEPC	% Soft rot	Aerial biomass
Not inoculated	100 a	639 a	0.7 a	2.69 a
Low	15 b	90 b	91 b	0.25 b
High	1 c	9 c	99 c	0.00 c
LSD (P=0.05)	38	5	5	0.24

Tuber age	% Emergence	AUEPC	% Soft	Aerial biomass
Normal	38	241	63	0.92
Intermediate	42	263	63	1.04
Old	36	233	66	0.98
LSD (P=0.05)	NSD	NSD	NSD	NSD

*Physiological aging temperature x inoculum density interaction significant in WA but not OR.

Table 3. Effect of seed piece treatments on response of seed tubers at different stages of infection with US-11 *P. infestans*.

Seed piece fungicide	% Emergence	AUEPC	Aerial bio-mass	% Soft rot
Inoculated tubers incubated 7.0 day				
Tops-Mancozeb	71	1086	224 a	42.5 a
Tops 5D	46	684	80 b	91.2 b
Control	56	758	51 b	92.5 b
LSD (P=0.05)	NSD	NSD	102.4	14.3
Inoculated tubers incubated 3.0 day				
Tops-Mancozeb	78	1066	150	37.5 a
Tops 5D	75	1074	150	61.2 b
Control	66	836	98	77.5 b
LSD (P=0.05)	NSD	NSD	NSD	17.2
Inoculated tubers incubated 1.5 day				
Tops-Mancozeb	89 a	1139 a	183 a	26.2 a
Tops 5D	50 b	628 b	13 b	95.0 b
Control	44 b	506 b	36 b	92.5 b
LSD (P=0.05)	14.9	230.2	129.8	10.5
Inoculated tubers incubated 0.5 day				
Tops-Mancozeb	98 a	1251 a	292 a	8.8 a
Tops 5D	23 b	268 b	7 b	100 b
Control	9 b	83 c	2 b	100 b
LSD (P=0.05)	13.8	152.3	68.3	11.8
Noninoculated tubers incubated 0 day				
Tops-Mancozeb	100	1277	0	305
Tops 5D	98	1360	6.2	316
Control	100	1376	2.5	253
LSD (P=0.05)	NSD	NSD	NSD	NSD

* Means followed by different letters within a column are not significantly different and reflect significant incubation time x seed treatment interaction.

Table 4. Washington seed piece fungicide evaluation (US-11 *P. infestans*).

Treatment and product/cwt	% Emergence 6/17	Transmission of US-11 detected 6/17	AUEPC[1]	Top fresh weight (lb)/plot[2] 7/15	Total tuber weight (lb)/plot 7/15	Percent Healthy Seed Piece 7/15
Not inoculated						
Nontreated control	99 ab	0	1190 ab	22 a	8 ab	69 bc
Tops-Mancozeb .75 lb	98 ab	0	1226 a	25 a	10 a	87 a
Inoculated						
Tops-Mancozeb .75 lb.	96 b	0	1150 abc	20 a	8 ab	77 ab
LS 214 .75 lb	100 a	0	1090 bcd	22 a	9 ab	81 ab
Tops-Mancozeb-Curzate .75 lb	98 ab	0	1089 bcd	23 a	9 ab	82 ab
Maxim-Mancozeb 0 .50 lb	99 ab	0	1070 cd	25 a	9 ab	75 abc
Mancozeb-Curzate .75 lb	97 ab	0	1067 cd	19 a	8 ab	60 c
Seed Treatment for Potatoes 1 lb	98 ab	0	1026 d	21 a	7 b	76 ab
Nontreated control	27 c	1	249 e	3 b	1 c	9 d
LSD (P=0.05)[3]	*3.6*	---	*116.5*	*8.6*	*2.2*	*15.4*

[1]AUEPC = area under emergence progress curve based on days after planting. Plots were rated daily (30 May through 17 June) for number of emerged plants. [2]Numbers within a column followed by the same letter are not significantly different as determined by least significant difference (LSD) test. *P* value is for analysis of variance. LS 214, Mancozeb-Curzate, Tops-Mancozeb, and Tops-Mancozeb-Curzate by Gustafson, Incorporated, P.O. Box 660065, Dallas, TX 75266-0065; Maxim-Mancozeb by Novartis Crop Protection Ag Products P.O. Box 18300, Greensboro, NC 27419; Seed Treatment for Potatoes (Maneb+Streptomycin Sulfate) by Helena Chemical Company, 6075 Poplar Ave., Suite 500, Memphis, TN 38119.