DEVELOPMENT OF LATE BLIGHT TUBER ROT IN STORAGE OF NINE POTATO CLONES

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Introduction

Potato late blight, caused by *Phytophthora infestans* severely reduces yield in storage. Tubers become infected during the growing season when sporangia or zoospores wash from the surface of infected stems or leaves, penetrate the soil and come in contact with tubers. During harvest, tubers can also become infected when contaminated with inoculum in the canopy. Tuber infection can occur through wounds, eyes, or lenticels. Tuber lesions appear as dark brown areas and initial spread is most rapid under the periderm of the tuber. Infection by *P. infestans* generally leads to secondary invasion by bacterial soft rot.

Methods and Materials

Tubers of nine potato clones were inoculated with *P. infestans* strain US-8 and then placed in a mist chamber for 16 hours. The maximum and minimum temperatures during the wet period were 63 and 54°F, respectively. The tubers were then air dried at approximately 63°F for 9 hours. After drying, tubers of each clone were placed in storage for 91 days at 40, 44, or 48°F. Tubers were then rated for percent internal rot. Additional experiments with tubers of the nine clones stored at 48°F were performed. Percent internal rot assessed and time until initial sporulation was assessed at three temperatures.

In another experiment, Russet Burbank tubers were inoculated with *P. infestans* strain US-8 and stored at either 40°F or 48°F. Solutions containing 1, 5, 50, and 500 sporangia were used to inoculate the tubers. Tubers were put into two mist chambers for a 44 hour wet period. After the wet period they were stored at either 40 or 48°F. Approximately every five weeks, for five different sampling periods, six tubers from each concentration level were assessed for percent internal rot.

Results and Discussion

Clones varied significantly for mean percent internal rot at 40, 44, and 48°F (Table 1). Both lower temperatures had significantly less rot for all clones than those at 48°F ($P<0.05$). The average mean internal rot combining all clones at 40, 44, and 48°F was 1.0, 0.6, and 14.3%, respectively. This experiment needs to be repeated, but the results suggest tubers can be stored at 44 instead of 40°F and still have substantial retardation of late blight rot development. Russet Burbank, Russet Legend, A90586-11, Umatilla, Gem Russet, and A84118-3 showed the most resistance to late blight with no significant differences between them for internal rot at 48°F. At 48°F, Ranger Russet was significantly more susceptible to internal rot than were all other clones by 60% or greater. At 48°F, Bannock Russet was also significantly more susceptible than were all other clones except Ranger Russet which was more susceptible, and Russet Norkotah which showed no significant difference from Bannock Russet in susceptibility (Table 1).

A definite division was observed in amount of internal rot between susceptible and resistant clones. Ranger was most prone to infection by *P. infestans* and had a significantly higher percent incidence and internal rot than all other clones. Norkotah and Bannock were also

highly susceptible to initial infection and were significantly higher in percent internal rot than all other clones tested except Ranger. Umatilla had a high percent incidence and a very low percent internal rot of 1%. This suggests that Umatilla is susceptible to initial infection but resistant to spread within the tuber. Although Norkotah and Bannock showed no significant differences in incidence for late blight rot compared to Russet Burbank, Umatilla, Gem, Legend, and A90586-11, both clones had significantly higher percent internal rot. Russet Burbank had no significant differences in incidence for late blight compared to Norkotah, Bannock, Umatilla, Gem, Legend, and A90586-11, but compared to these same clones for internal rot it was significantly more than Umatilla, Legend, and A90586-11. A84118-3, A90586-11, and Legend appear to be the most resistant to late blight rot development (Table 2).

Incidence of late blight in Russet Burbank tubers was not affected by storage temperatures or time after inoculation for the sampling periods observed (Figure 5). However, incidence was dependent on inoculum concentration levels. Tubers inoculated with 500 and 50 sporangia had significantly higher levels of incidence than those inoculated with 5 sporangia or 1 sporangium (Figures 1&2). Two separate experiments showed mixed results for incidence comparing treatments of 500 and 50 sporangia. In one experiment, tubers treated with 500 sporangia had a significantly higher percent incidence while in the other experiment there was no significant difference between the two inoculum levels (Figures 5 & 6).

Internal rot of Russet Burbank tubers depended on storage temperature, concentration levels of inoculum, and time in storage. Internal tuber rot was significantly lower at lower storage temperatures (Figure 7). The mean percent internal rot for tubers stored at 40°F and 48°F were 3.5 and 18.9%, respectively.

Concentration levels of inoculum had a significant impact on the percent internal rot only at 48°F. Two separate experiments showed mixed results for differences in internal rot comparing 500 and 50 sporangia. In one experiment 500 sporangia caused significantly more internal rot while in the other experiment there was no significant difference between the inoculum levels (Figure 3). Concentration levels of 5 sporangia and 1 sporangium had significantly less internal rot than 50 and 500. A concentration level of 5 sporangia was also significantly higher in internal rot than 1 sporangium. At 40 or 48°F there were no significant differences in internal rot among the first three sampling periods, 6, 11, 16 weeks. During the last two sampling periods, 21 and 26 weeks, the amount of rot significantly increased at 48°F (Figure 3) but remained low at 40° (Figure 7).

Time until initial sporulation significantly increased with decreasing temperature. Infected tubers at 50°F took significantly longer to sporulate than tubers at 77 and 64°F (Table 3).

Conclusions

Tuber infection by *P. infestans* occurred at low concentration levels. Management practices to avoid contact of tubers with any amount of inoculum is paramount. Within 5 weeks of storage, detection of infection was possible at a storage temperature of 48°F. Storage temperatures around 40 to 44°F significantly retarded development of late blight rot and also appeared to reduce the amount of soft rot due to secondary pathogens that follow infection by *P. infestans*. Many of the different potato clones tested were resistant to *P. infestans* infection and show potential for becoming marketable disease resistant cultivars.

Figures and Tables:

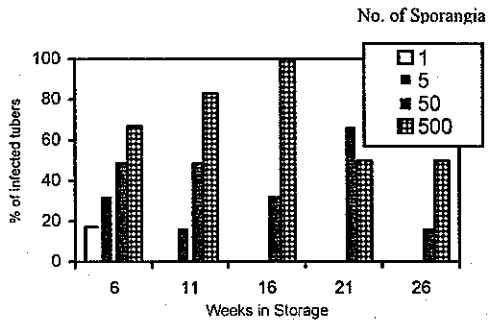


Figure 1. Percent incidence of late blight rot in Russet Burbank tubers at different inoculum levels stored for 6-26 week at 48°F.

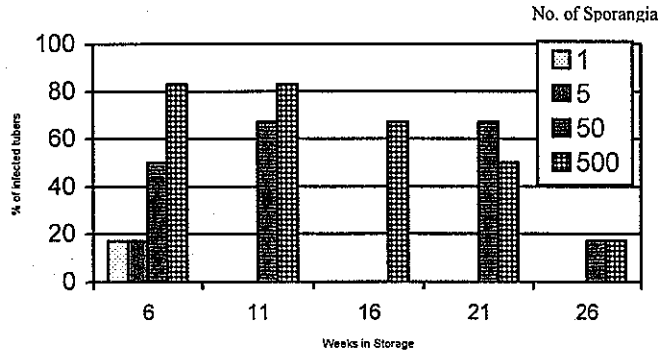


Figure 2. Percent incidence of late blight rot in Russet Burbank tubers at different inoculum levels stored for 6-26 weeks at 40°F.

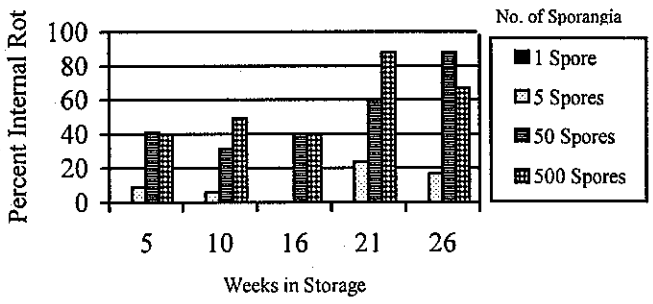


Figure 3. Percent internal rot in Russet Burbank tubers at different inoculum levels stored for 5-26 weeks at 48°F.

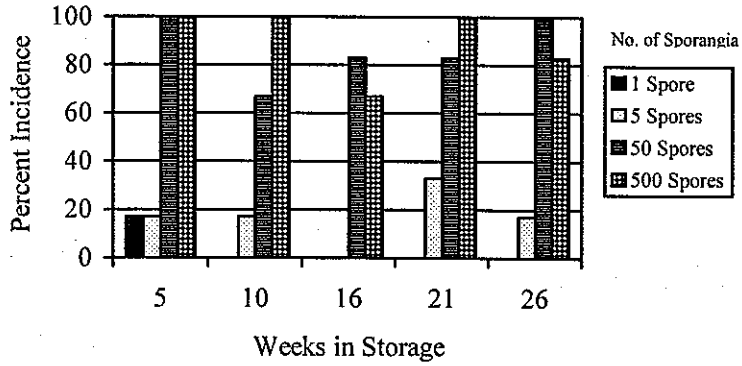


Figure 4. Percent incidence of late blight rot in Russet Burbank tubers at different inoculum levels stored for 5-26 weeks at 48°F.

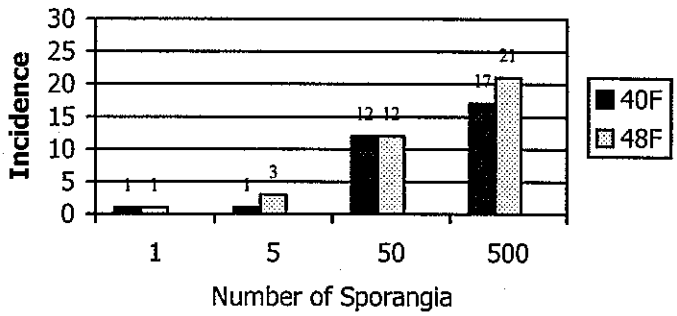


Figure 5. Incidence of late blight rot in Russet Burbank tubers at two storage temperatures and four inoculum levels. n = 30/ temperature-inoculum level combination.

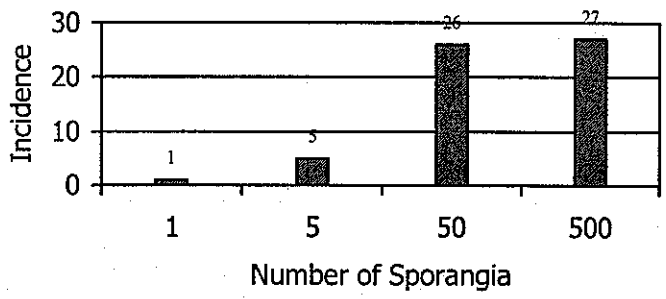
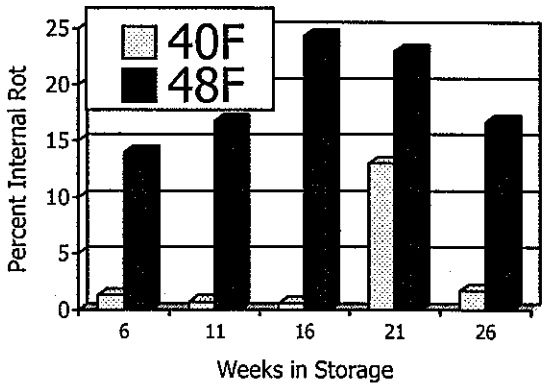


Figure 6. Incidence of late blight rot in Russet Burbank tubers at four concentrations of



inoculum at 48°F, n = 30/concentration level.

Figure 7. Percent internal tuber rot in Russet Burbank tubers stored at 40 and 48°F for 6-26 weeks.

Table 1. Percentage of internal tuber area with late blight rot *.

Variety	40°F	44°F	48°F
Ranger	5.7 a	.3 b	88 a
Bannock	2.8 ab	3.5 a	28.3 b
Norkotah	0 b	.4 b	7.5 c
R. Burbank	.1 b	.05 b	0 c
Legend	.3 b	.1 b	.4 c
A90586-11	.1 b	0 b	.2 c
Umatilla	.1 b	.1 b	.1 c
Gem	0 b	.03 b	.2 c
A84118-3	.03 b	0 b	0 c
Means	1.0a	.6a	14.3b

*Letters represent significant differences between percent internal rot using Fisher LSD.

Table 2. Percent incidence and internal rot for nine clones of tubers at 48°F. The percentages are the combination of four separate tests *.

Variety	% Incidence	% Internal Rot	Sample Size
Ranger	83a	68a	29
Norkotah	59b	32b	27
Bannock	51bc	23b	35
Umatilla	40bcd	1 d	29
Gem	32 cde	2cd	31
R. Burbank	31 cde	12c	32

Legend	21	def	1 d	30
A90586-11	16	ef	.04 d	25
A84118-3	9	f	3 cd	32

*Letters represent significant differences between percent incidence and internal rot using Fisher LSD.

Table 3. Time until initial sporulation in hours of *P. infestans* at three temperatures*.

Variety	77°F	64°F	50°F
Bannock	17	19	24
R. Burbank	18	19	31
Norkotah	17	19	32
Legend	18	19	32
Ranger	17	19	46
Gem	-	-	-
Umatilla	-	-	-
A84118-3	-	-	-
A90586-11	-	-	-

* "-" signifies there was not sufficient infection to get good sporulation data.