CHAPTER 16: ANSWER KEY

Survival Analysis of Time-to-Event Data
in Botanical Epidemiology

Peter S. Ojiambo
Department of Plant Pathology
North Carolina State University, Raleigh, U.S.A.

Henry K. Ngugi
International Maize and Wheat Improvement Center (CIMMYT)
El Batan, Texcoco, Mexico

Harald Scherm
Department of Plant Pathology
University of Georgia, Athens, U.S.A.

Answers to Evaluation Questions

1. a. Leaves located lower in the canopy are expected to abscise earlier (i.e., have a lower
survival rate) than leaves in the upper canopy. This is expected because leaves in the
lower canopy are closer to overwintering inoculum that is splash dispersed and they
should become infected earlier.

b. The two groups of leaves do not differ significantly with respect to their survival times
following leaf infection with cherry leaf spot. Mean survival times:
canpygrp 1 = 51.92 (± 0.396) days; canpygrp 2 = 51.68 (± 0.518) days.

c. Possible explanations include (i) distances between the two canopy groups are not
sufficiently large enough to impact inoculum dispersal from the debris on the ground into
the canopy; (ii) differences in the microclimate within the two groups are not sufficiently
large enough to influence infection and disease severity.

2. a. Survival times are significantly different between the two groups of leaves. The main
difference between the two groups is observed approximately 30 days after initial
infection.

b. disclass 1 = 52.75 (± 0.305) days.
disclass 2 = 37.53 (± 1.308) days.

Leaves with an initial disease severity of ≤3 spots per leaf remain on the tree for about 16
days longer than leaves with an initial disease severity of >3 spots per leaf.

c. disclass 1 = 45.7%.
disclass 2 = 5.1%.

d. Yes; both the log-rank and Wilcoxon tests are highly significant ($P < 0.0001$).
3. a. \( \text{disclass} = 0.3732 \). 
Maximum disease severity = –0.0047.  
b. For \( \text{disclass} \), \( 100 \times (e^{\beta_1} - 1) = 45.3\% \); leaves in \( \text{disclass} \) 1 abscised 45% faster than those in \( \text{disclass} \) 2. For maximum disease, \( 100 \times (e^{\beta_1} - 1) = 0.5\% \); each additional leaf spot accelerates time to abscission by 0.5\%.

4. a. \( \text{disclass} = 1.3132 \).  
Maximum disease severity = 0.0187.  
b. \( \text{disclass} = 3.718 \).  
Maximum disease severity = 1.019.  
For \( \text{disclass} \), \( P = \frac{HR}{1 + HR} \); HR = 3.718 corresponds to a 78.8\% chance that leaves in \( \text{disclass} \) 1 will abscise before leaves in \( \text{disclass} \) 2. For maximum disease, HR = 1.019, and each additional spot increases the chance of abscission by 2\%.

5. a. \( \text{mxdis} = -0.0987; \text{mxdist} = 0.00247; \text{disclass} = 1.5473 \).  
b. Yes, the time-dependent covariate is highly significant \( (P < 0.0001), \chi^2 = 177.439 \).  
c. Model survival data with the AFT model instead.