Mathematical models are a powerful method to understand and control the spread of Huanglongbing

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Supplementary Article 2:
Additional Results for the Huanglongbing Model

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In the main text we indicate how the number of trees and psyllids in their various categories changes over the first 8 years after infection arrives (Figure 2). We include here, Figure S2.1, the simulation for the full 20 year time span to show how it settles down to a steady state, with yearly seasonality. The figure for the full 20 years shows that by the end the total number of removed trees is 160, and the number of infected trees remains around 90, which is nearly the whole grove infected at any one time.

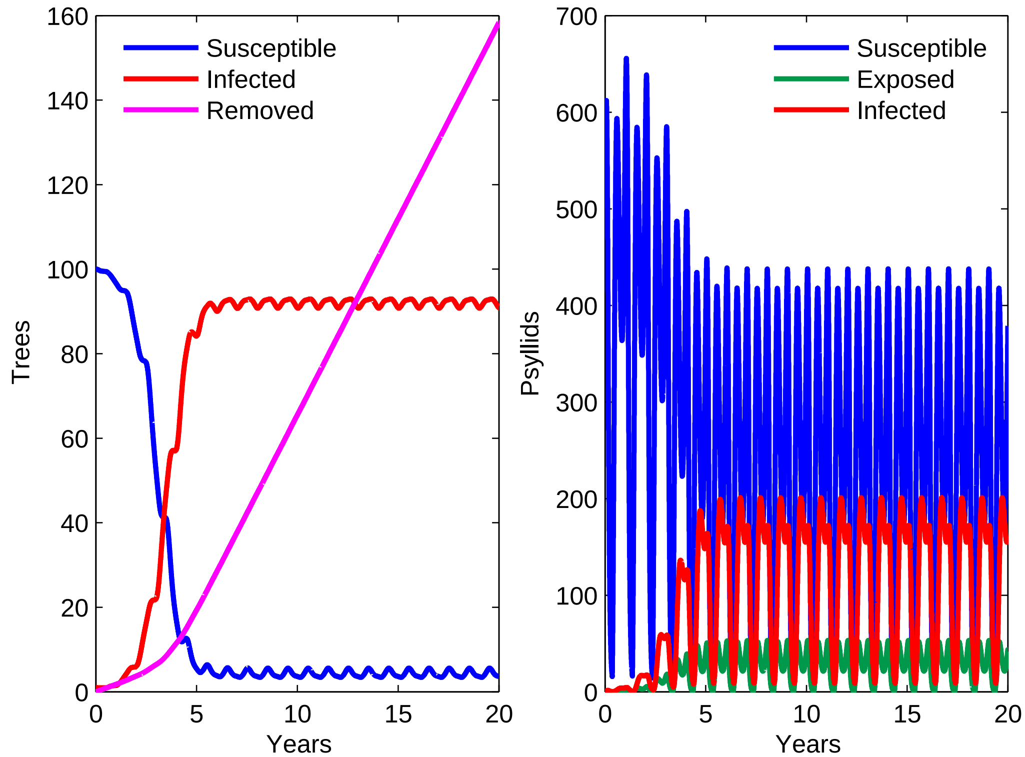

Figure S2.1: The changes in numbers of susceptible and infected trees and psyllids over 20 years when one tree is infected at time 0. Alive trees are either Susceptible (blue) or Infected (red), and Removed trees are also plotted (purple). Psyllids are Susceptible (blue), Exposed (green) or Infected (red).

In the main text, we also mentioned how it is roguing that prevents the infection from taking over the whole grove. If trees weren't rogued, all trees would remain infected rather than a cycle of replacing trees with susceptible trees which then become infected. We asked whether roguing at a higher rate, that is reducing the average time until a tree is rogued, would affect the maximum number of infected trees and the total number of trees that need replaced (Figure S2.2).

Detecting infection and roguing trees sooner reduces the peak number of infected trees from about 96 to 84 trees with a faster decline when the average time until trees are rogued is shorter (Figure S2.2). However, this is counterbalanced by an increase in removed trees, from 112 to 353 trees. These results are extreme but they serve to show the principle of ineffective control: in the current example, the benefits gained from having 12 disease-free citrus trees will be outweighed significantly by having to replant 241 more trees, both from the viewpoint of cost and logistics.

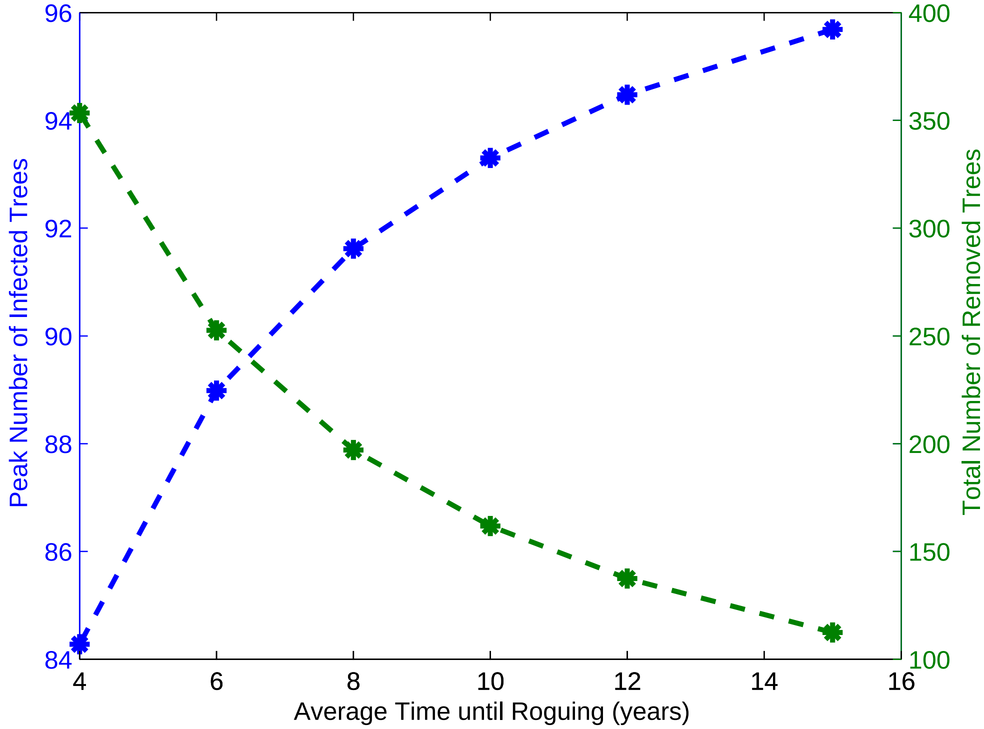

Figure S2.2: The effect of varying the average time until an infected tree is rogued on key features of disease spread. The mean time (in years) until an infected tree is rogued is varied from 4 to 15 years, thus the roguing rate varies between 0.25 to 0.067 respectively. The peak number of infected trees (blue) and the total number of removed trees (green) over a 20 year duration are plotted.

Sensitivity Analysis

We include here further details on the sensitivity analysis performed for the constant parameters. For each parameter p, we varied it by 10% (i.e. $0.9p$ and $1.1p$) and then calculated the size of R_0 at the maximum temperature (Figure 3B, main text). We output the low and high values for R_0 for each of these parameters to give more detail than the figure.

Parameter	Low R_0	High R_0
a	9.0918	11.1122
b	9.5836	10.5951
c	9.5836	10.5951
r_1	9.6319	10.6484
ϕ	9.9994	10.1868

Table S2.1: The low and high values of R_0 when each of the parameters p is changed to $0.9p$ and $1.1p$ as shown in Figure 3B. These are calculated when $T = 23.43$, when R_0 is at its maximum value of 10.1.