Supporting Information

S1 Generalized interference functions

The visiting and emigration interference functions presented in the main text for the direct and indirect interference scenarios (equation 4 and 5 in the main text) can be extended to include also intermediate interference scenarios via the following functions:

$$f(N_R) = \frac{1}{1 + \left(\frac{\nu_1}{h_R^{1-\beta_1}} \frac{N_R}{h^{\beta_1}} \right)^{\alpha_1}} \qquad g(N_R) = 1 + \left(\frac{\nu_2}{h_R^{1-\beta_2}} \frac{N_R}{h^{\beta_2}} \right)^{\alpha_2} \tag{1}$$

The parameter $\beta_1 \in [0, 1]$ ($\beta_2 \in [0, 1]$) allows different interference scenarios to be represented. When $\beta_1 = 1$ ($\beta_2 = 1$), the function $f(N_R)$ [$g(N_R)$] represents direct interference, when $\beta_1 = 0$, the function $f(N_R)$ [$g(N_R)$] represents indirect interference, when $0 < \beta_1 < 1$ the function $f(N_R)$ [$g(N_R)$] represents forms of interference between these two extremes. The other parameters have the same interpretations as in the main text. Note that, in our model, the value of the "strength" parameter ν_1 (ν_2) is defined for the direct interference scenario ($\beta_1 = \beta_2 = 1$). To assure that its value is biologically relevant also for other interference scenarios, we scale it with $h_R^{1-\beta_1}$ ($h_R^{1-\beta_2}$). This implies that, when $h = h_R$ - all other things being equal [*i.e.* the values of α_1 (α_2) and N_R] - the value of the interference function is the same independently from the underlying interference scenario.

S2 Non dimensionalization

The system of differential equations corresponding to the model, after integrating the assumption in the main text (N_P constant and $\lambda = T\tau$), and after including the dynamics of the population size of resident ($N_R = X_R + Z_R$) and transient ($N_T = X_T + Z_T$) aphids, can be rewritten as

$$\begin{cases} \dot{I} = (\Lambda_R \delta_R Z_R + \Lambda_T \delta_T f(N_R) Z_T)(N_P - I) - (\rho + \theta) I \\ \dot{N_R} = r N_R (1 - \frac{N_R}{h}) - \mu N_R \\ \dot{Z_R} = \Lambda_R \varepsilon_R \frac{I}{N_P}(N_R - Z_R) - (\gamma + \mu) Z_R \\ \dot{N_T} = \tau (T - g(N_R) N_T) \\ \dot{Z_T} = \pi \tau T + \Lambda_T \varepsilon_T f(N_R) \frac{I}{N_P}(N_T - Z_T) - (\gamma + \tau g(N_R)) Z_T \end{cases} \tag{2}$$

Where

$$f(N_R) = \frac{1}{1 + \left(\frac{\nu_1}{h_R^{1-\beta_1}} \frac{N_R}{h^{\beta_1}} \right)^{\alpha_1}} \tag{3}$$

$$g(N_R) = 1 + \left(\frac{\nu_2}{h_R^{1-\beta_2}} \frac{N_R}{h^{\beta_2}} \right)^{\alpha_2} \tag{4}$$

Note that, as presented in the previous section, by considering $\beta_1 = 1$ ($\beta_1 = 0$) the visiting interference function $f(N_R)$ represents the direct (indirect) interference scenario presented in the main text. Similar considerations are taken for the emigration interference $g(N_R)$.

The equations of $\dot{S}$, $\dot{X}_R$ and $\dot{X}_T$ have been omitted because they can be derived from $S = N_P - I$, $X_R = N_R - Z_R$ and $X_T = N_T - Z_T$, respectively. To highlight the resident aphid carrying capacity, the equation for N_R can be rewritten as

$$\dot{N_R} = r'\Big(1 - \frac{N_R}{\kappa}\Big) \tag{5}$$

where

$$r' = r - \mu \qquad \kappa = h\Big(1 - \frac{\mu}{r}\Big) \tag{6}$$

By making the transformation

$$I = N_P \hat{I} \tag{7}$$

$$N_R = \kappa \hat{N}_R \tag{8}$$

$$Z_R = \kappa \hat{Z}_R \tag{9}$$

$$N_T = T \hat{N}_T \tag{10}$$

$$Z_T = T \hat{Z}_T \tag{11}$$

$$t = \frac{\hat{t}}{\rho + \theta} \tag{12}$$

and writing

$$f(\hat{N}_R) = \frac{1}{1 + \left(\frac{\nu_1}{\hat{h_R}^{1-\beta_1}} \frac{\hat{N}_R}{\hat{h}^{\beta_1}} \right)^{\alpha_1}} = f(\cdot) \tag{13}$$

$$g(\hat{N}_R) = 1 + \left(\frac{\nu_2}{\hat{h_R}^{1-\beta_2}} \frac{\hat{N}_R}{\hat{h}^{\beta_2}} \right)^{\alpha_2} = g(\cdot) \tag{14}$$

where $\hat{h}_R$, $\hat{h}_1$ and $\hat{h}_2$ are the non dimensional versions of the parameter

h_R, h_1 and h_2, that is

$$h_R = \kappa \hat{h}_R \tag{15}$$

$$h_1 = \kappa \hat{h}_1 \tag{16}$$

$$h_2 = \kappa \hat{h}_2 \tag{17}$$

we obtained a nondimensionalized version of the original model equations:

$$\begin{cases} \dot{\hat{I}} = \left(i_R \hat{Z}_R + i_T f(\cdot) \hat{Z}_T\right)(1 - \hat{I}) - \hat{I} \\ \dot{\hat{N}}_R = q \hat{N}_R \left(1 - \hat{N}_R\right) \\ \dot{\hat{Z}}_R = a_R(\hat{N}_R - \hat{Z}_R)\hat{I} - m\hat{Z}_R \\ \dot{\hat{N}}_T = e(1 - g(\cdot)\hat{N}_T) \\ \dot{\hat{Z}}_T = u + a_T f(\cdot)(\hat{N}_T - \hat{Z}_T)\hat{I} - (d + eg(\cdot))\hat{Z}_T \end{cases} \tag{18}$$

The composite parameters are given by

$$i_R = \frac{\Lambda_R \delta_R \kappa}{\rho + \theta} \qquad i_T = \frac{\Lambda_T \delta_T T}{\rho + \theta} \qquad q = \frac{r'}{\rho + \theta} \tag{19}$$

$$a_R = \frac{\Lambda_R \varepsilon_R}{\rho + \theta} \qquad m = \frac{\gamma + \mu}{\rho + \theta} \qquad u = \frac{\pi \tau}{\rho + \theta} \tag{20}$$

$$a_T = \frac{\Lambda_T \varepsilon_T}{\rho + \theta} \qquad d = \frac{\gamma}{\rho + \theta} \qquad e = \frac{\tau}{\rho + \theta} \tag{21}$$

S3 Basic reproduction number

Considering the infected subsystem (*i.e.* the equations that describe the production of new infections and changes in state among infected individuals) of the nondimenional system in equation 18, linearized around the infection-free steady state, and assuming that $u = 0$, which is equivalent to assuming that only non viruliferous transient aphids immigrate into the system, we determined the basic reproduction number of the disease, R_0, using the next generation method [1].

The matrix F describes the production of new infections and matrix the V describes changes in state.

$$F = \begin{bmatrix} 0 & i_R & i_T f(\cdot) \\ a_R \hat{N}_R & 0 & 0 \\ a_T f(\cdot) \hat{N}_T & 0 & 0 \end{bmatrix} \qquad V = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -m & 0 \\ 0 & 0 & -(d + eg(\cdot)) \end{bmatrix} \tag{22}$$

$$F(-V)^{-1} = \begin{bmatrix} 0 & \frac{i_R}{m} & \frac{i_T f(\cdot)}{d+eg(\cdot)} \\ a_R \hat{N}_R & 0 & 0 \\ a_T f(\cdot) \hat{N}_T & 0 & 0 \end{bmatrix} \tag{23}$$

The basic reproduction number is the dominant eigenvalue (Λ) of the matrix $F(-V)^{-1}$, which can be easily computed by the characteristic equation of the matrix $F(-V)^{-1}$:

$$\Lambda^2 - \frac{i_R}{m} a_R \hat{N}_R - \frac{i_T f(\cdot)^2}{d + eg(\cdot)} a_T \hat{N}_T = 0 \tag{24}$$

Note that, from equation (18), i) the value of $\hat{N}_R$ at the infection-free steady state is $\hat{N}_R = 1$ when $q > 0$ and $\hat{N}_R = 0$ when $q < 0$, and ii) the value of $\hat{N}_T$

at the infection-free steady state is $\hat{N}_T = \frac{1}{g(\cdot)}$.

$$R_0 = \frac{i_R a_R}{m} + \frac{i_T f(\cdot)^2 a_T}{g(\cdot)(d + eg(\cdot))} = R_0^R + R_0^T \qquad \text{if q} > 0 \tag{25}$$

$$R_0 = \frac{i_T f(\cdot)^2 a_T}{g(\cdot)(d + eg(\cdot))} = R_0^T \qquad \text{if q} < 0 \tag{26}$$

where R_0^R corresponds to the virus transmission by resident aphids and R_0^T considers the virus transmission by transient aphids. It is important to note that the quantities identified in equations (25) and (26) are actually R_0^2, since two cycles are involved in transmission, *i.e.* from plant to vector and from vector to plant [2]. However, since the two thresholds predict identical behaviour in terms of disease invasion (the threshold $R_0 = 1$ is precisely equivalent to $R_0^2 = 1$), we prefer to use the simpler formulation in our work.

The basic reproduction number can be rewritten with biological parameters, considering that at the infection-free steady state the value of $N_R = \kappa$ if $r > \mu$, or $N_R = 0$, otherwise, and the value of $N_T = \frac{T}{g(\kappa)}$. The interference functions $f(\cdot)$ and $g(\cdot)$ are equal to 1 if $N_R = 0$.

$$R_0 = \frac{1}{\rho + \theta}\left(\frac{\Lambda_R^2 \delta_R \varepsilon_R \kappa}{\gamma + \mu} + \frac{\Lambda_T^2 \delta_T \varepsilon_T f(\kappa)^2 T}{g(\kappa)(\gamma + \tau g(\kappa))}\right) \text{ if } r > \mu \tag{27}$$

$$R_0 = \frac{\Lambda_T^2 \delta_T \varepsilon_T T}{(\rho + \theta)(\gamma + \tau)} \text{ if } r < \mu \tag{28}$$

S4 Epidemic equilibrium

The equilibrium values of $\hat{N}_R$ come from a solution of

$$0 = q\hat{N}_R(1 - \hat{N}_R) \tag{29}$$

When $q = r - \mu < 0$, the equilibrium that is stable in the long term is $\hat{N}_R = 0$, when $q = r - \mu \geq 0$ the equilibrium that is stable in the long term is $\hat{N}_R = 1$. The equilibrium value of $\hat{N}_T$ comes from the solution of

$$
\begin{aligned}
0 &= e(1 - g(\cdot)\hat{N}_T) && (30)\\
\hat{N}_T &= \frac{1}{g(\cdot)} && (31)
\end{aligned}
$$

$\hat{\mathbf{N}}_{\mathbf{R}} = \mathbf{0}$

If the equilibrium value of $\hat{N}_R$ is 0, it follows that the equilibrium value of $\hat{Z}_R$ is 0, $f(\cdot) = 1$, $g(\cdot) = 1$ and consequently the equilibrium value of $\hat{N}_T = 1$. The equilibrium values of $\hat{I}$ and $\hat{Z}_T$ come from a solution to

$$
\begin{aligned}
0 &= i_T \hat{Z}_T \Big(1 - \hat{I}) - \hat{I} && (32)\\
0 &= u + a_T(1 - \hat{Z}_T)\hat{I} - (d + e)\hat{Z}_T && (33)
\end{aligned}
$$

The second equation indicates

$$
\hat{Z}_T = \frac{u + a_T \hat{I}}{a_T \hat{I} + d + e} \qquad (34)
$$

Back subbing into the first equation

$$
0 = \left(i_T \frac{u + a_T \hat{I}}{a_T \hat{I} + d + e} \right)(1 - \hat{I}) - \hat{I} \qquad (35)
$$

The number and nature of the equilibria implied by equation 35 depends on whether or not there is immigration of viruliferous vectors (*i.e.* $u = 0$ or $u > 0$).

- $\boldsymbol{u = 0}$

  If $u = 0$, which is equivalent to assuming that all the aphids entering the system are non viruliferous, the equation (35) can be rewritten as

$$0 = \hat{I}\left(\left(\frac{i_T a_T}{a_T \hat{I} + d + e}\right)(1 - \hat{I}) - 1\right) \tag{36}$$

  which means there is one root when $\hat{I} = 0$ and one root comes from the solution to

$$\frac{i_T a_T}{a_T \hat{I} + d + e} = \frac{1}{(1 - \hat{I})} \tag{37}$$

  After algebraic manipulations, recalling that $R_0^T = \frac{i_T a_T}{d+e}$ when $f(\cdot) = g(\cdot) = 1$, the solution to equation (37) is

$$\hat{I} = \frac{R_0^T - 1}{R_0^T + a_T/(d + e)} \tag{38}$$

  which, for $R_0^T > 1$, is always in the biologically-meaningful interval [0,1].

- $\boldsymbol{u > 0}$

  If $u > 0$, which is equivalent to assuming that transient aphids can bear the disease from outside the system, $\hat{I} = 0$ is not a solution of equation

(35), so it is acceptable to divide equation (35) by $\hat{I}$, leading to

$$
\begin{aligned}
0 &= \left(\frac{i_T u}{\hat{I}(a_T\hat{I}+d+e)} + \frac{i_T a_T}{a_T\hat{I}+d+e}\right)(1-\hat{I}) - 1 && (39)\\
\frac{1}{1-\hat{I}} &= \frac{i_T u}{\hat{I}(a_T\hat{I}+d+e)} + \frac{i_T a_T}{a_T\hat{I}+d+e} && (40)\\
v(\hat{I}) &= b_1(\hat{I}) && (41)
\end{aligned}
$$

The function $b_1(\hat{I})$ is: i) always positive for $\hat{I} \in (0,1]$; ii) always decreasing; iii) has $b_1(\hat{I}) \to +\infty$ as $\hat{I} \to 0^+$. The function $v(\hat{I})$ i) is always positive for $\hat{I} \in [0,1)$; ii) is always increasing; iii) has $v(0) = 1$ and has $v(\hat{I}) \to +\infty$ as $\hat{I} \to 1^-$. Taken together the properties of $b_1(\hat{I})$ and $v(\hat{I})$, we can conclude that there is always a single biologically meaningful root with $\hat{I} \in (0,1)$ (irrespective of the values of parameters) (Fig. S1A).

$\hat{\mathbf{N}}_{\mathbf{R}} = \mathbf{1}$

If the equilibrium value of $\hat{N}_R$ is 1, it follows that $f(\cdot) = \frac{1}{1+\left(\frac{\nu_1}{\hat{h_R}^{1-\beta_1}\hat{h}^{\beta_1}}\right)^{\alpha_1}} = f$, $g(\cdot) = 1+\left(\frac{\nu_2}{\hat{h_R}^{1-\beta_2}\hat{h}^{\beta_2}}\right)^{\alpha_2} = g$, and the equilibrium value of $\hat{N}_T = \frac{1}{g}$. The equilibrium value of $\hat{I}$, $\hat{Z}_R$ and $\hat{Z}_T$ come from a solution to

$$
\begin{aligned}
0 &= \left(i_R\hat{Z}_R + i_T f\hat{Z}_T\right)(1-\hat{I}) - \hat{I} && (42)\\
0 &= a_R(1-\hat{Z}_R)\hat{I} - m\hat{Z}_R && (43)\\
0 &= u + a_T f\left(\frac{1}{g} - \hat{Z}_T\right)\hat{I} - (d+eg)\hat{Z}_T && (44)
\end{aligned}
$$

The second and third equations indicate

$$\hat{Z}_R = \frac{a_R \hat{I}}{a_R \hat{I} + m} \quad (45)$$

$$\hat{Z}_T = \frac{ug + a_T f \hat{I}}{g(a_T f \hat{I} + d + eg)} \quad (46)$$

Back subbing into the first equation

$$0 = \left(i_R \frac{a_R \hat{I}}{a_R \hat{I} + m} + i_T f \frac{ug + a_T f \hat{I}}{g(a_T f \hat{I} + d + eg)} \right) (1 - \hat{I}) - \hat{I} \quad (47)$$

Again, the number and nature of the equilibria implied by equation 47 depends on whether or not there is immigration of viruliferous vectors (*i.e.* $u = 0$ or $u > 0$).

- $\boldsymbol{u = 0}$

  If $u = 0$, equation (47) can be rewritten as

$$0 = \hat{I} \left(\left(\frac{i_R a_R}{a_R \hat{I} + m} + \frac{i_T a_T f^2}{g(a_T f \hat{I} + d + eg)} \right) (1 - \hat{I}) - 1 \right) \quad (48)$$

  which means there is one root when $\hat{I} = 0$ and others come from the solutions to

$$\left(\frac{i_R a_R}{a_R \hat{I} + m} + \frac{i_T a_T f^2}{g(a_T f \hat{I} + d + eg)} \right) = \frac{1}{(1 - \hat{I})}, \quad (49)$$

The exact equilibrium value of $\hat{I}$ can be found by solving equation (49)

$$\left(\frac{i_R a_R/m}{a_R\hat{I}/m+1} + \frac{i_T a_T f^2/(g(d+eg))}{a_T f\hat{I}/(d+eg)+1}\right) = \frac{1}{(1-\hat{I})} \tag{50}$$

$$\frac{R_0^R}{(a_R\hat{I}/m)+1} + \frac{R_0^T}{a_T f\hat{I}/(d+eg)+1} = \frac{1}{1-\hat{I}} \tag{51}$$

After algebraic manipulation equation (51) can be written as

$$a_2\hat{I}^2 + a_1\hat{I} + a_0 = 0 \tag{52}$$

$$p(\hat{I}) = 0 \tag{53}$$

Where

$$a_2 = -\Big(R_0^R\frac{a_T f}{d+eg} + R_0^T\frac{a_R}{m} + \frac{a_R a_T f}{m(d+eg)}\Big) \tag{54}$$

$$a_1 = \Big(\frac{a_T f}{d+eg}(R_0^R-1) + \frac{a_R}{m}(R_0^T-1) - (R_0^R+R_0^T)\Big) \tag{55}$$

$$a_0 = R_0^R + R_0^T - 1 \tag{56}$$

Since $a_2 < 0$, when $a_0 > 0$, which corresponds to $R_0^R + R_0^T = R_0 > 1$, the quadratic function $p(\hat{I})$ in equation (52) has two roots, one positive and one negative. Since $p(1) = a_2 + a_1 + a_0 = -\left(\frac{a_R a_T f}{m(d+eg)} + \frac{a_T f}{d+eg} + \frac{a_R}{m} + 1\right) < 0$ the positive root must have $\hat{I} < 1$ by the intermediate value theorem, thus it is in the biologically meaningful interval $[0, 1]$.

We can conclude that equation (52) has one biologically meaningful solution, expressed as

$$\hat{I} = \frac{-a_1 - \sqrt{a_1^2 - 4a_2a_0}}{2a_2} \tag{57}$$

- $\boldsymbol{u > 0}$

If $u > 0$, $\hat{I} = 0$ is not a solution of equation (47), so it is acceptable to divide equation (47) by $\hat{I}$, leading to

$$0 = \left(\frac{i_R a_R}{a_R\hat{I} + m} + \frac{i_T f u}{\hat{I}(a_T f\hat{I} + d + eg)} + \frac{i_T a_T f^2}{g(a_T f\hat{I} + d + eg)}\right)(1 - \hat{I}) - 1 \tag{58}$$

$$\frac{1}{1 - \hat{I}} = \left(\frac{i_R a_R}{a_R\hat{I} + m} + \frac{i_T f u}{\hat{I}(a_T f\hat{I} + d + eg)} + \frac{i_T a_T f^2}{g(a_T f\hat{I} + d + eg)}\right) \tag{59}$$

$$v(\hat{I}) = b_2(\hat{I}) \tag{60}$$

The function, $v(\hat{I})$ has the same properties as before, whereas the function $b_2(\hat{I})$ is: *i*) always positive on the interval $\hat{I} \in (0, 1)$; *ii*) always decreasing; *iii*) has $b_2(\hat{I}) \to +\infty$ as $\hat{I} \to 0^+$. Taken together with the properties of $v(\hat{I})$ this means there is always a single biologically meaningful root with $\hat{I} \in (0, 1)$ (irrespective of the values of parameters) (Fig. S1B).

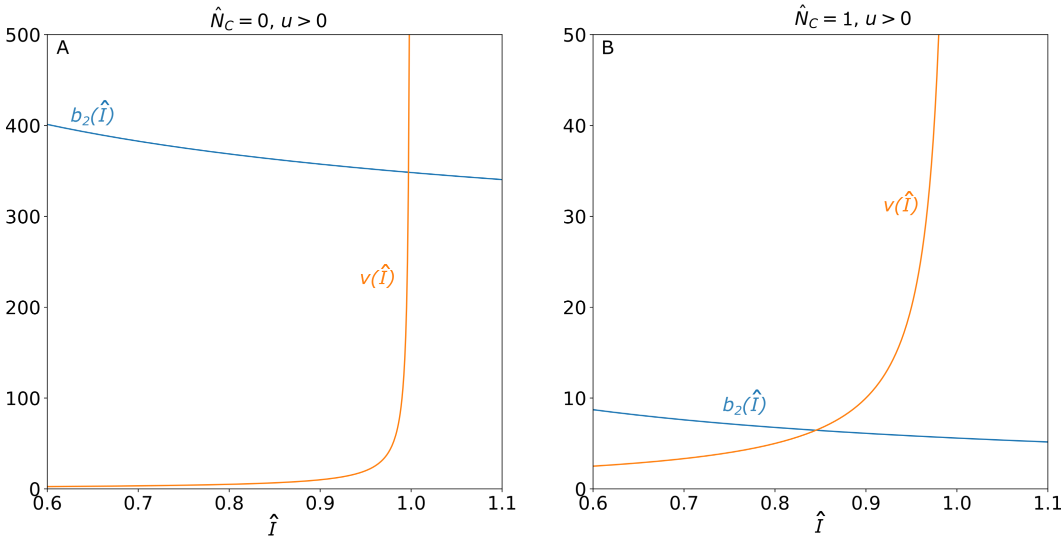

Figure S1: Graphical representation of A) functions $b_1(\hat{I})$ and $v(\hat{I})$ and B) functions $b_2(\hat{I})$ and $v(\hat{I})$. Function $v(\hat{I})$ is the same in A) and B), but values on the y-axis are different to facilitate figure interpretation. The intersection of the two functions identifies the equilibrium value of $\hat{I}$. $\nu = 12.0$, $\pi = 0.1$, other parameters are set to default values.

The model behaviour at equilibrium is summarized in Table S1 in the *Supporting Information*, which enriches Table 2 in the main text. Moreover, for 5000 sets of parameter values randomly selected from the range $[0.8P; 1.2P]$ where P is the default value of each of the parameters, in all cases the result of the numerical simulation matches the results of the mathematical analysis, as well as the stability properties of the equilibria.

Table S1: Summary of equilibrium behaviour. The value of the nondimensionalized state variables at the equilibrium are indicated in the forth column. Where, for space limitation, is was not possible to report the equilibrium expression, the reference to the corresponding equation is reported.

Viruliferous aphids enter the system ($u > 0$)	Resident aphids are present ($q > 0$)	Basic reproduction number (eq. 25)	$(\hat{I}, \hat{N}_R, \hat{Z}_R, \hat{N}_T, \hat{Z}_T)$	Explanation
no	no	$R_0 < 1$	(0, 0, 0, 1, eq. 34)	Transient aphids do not bear the disease from outside the system. Resident aphids are absent, the disease is spread by transient aphids but it does not persist in the system.
no	no	$R_0 > 1$	(eq. 38, 0, 0, 1, eq. 34)	Transient aphids do not bear the disease from outside the system. Resident aphids are absent, the disease is spread by transient aphids.
no	yes	$R_0 < 1$	(0, 1, eq. 45, $\frac{1}{g}$, eq. 46)	Transient aphids do not bear the disease from outside the system. Resident and transient aphids spread the disease, but it does not persist in the system.
no	yes	$R_0 > 1$	(eq. 57, 1, eq. 45, $\frac{1}{g}$, eq. 46)	Transient aphids do not bear the disease from outside the system. Resident and transient aphids spread the disease.
yes	no	- *	(eq. 41, 0, 0, 1, eq. 34)	Transient aphids bear the disease from outside the system. Resident aphids are absent, transient aphids spread the disease.
yes	no	- *	(eq. 60, 1, eq. 45, $\frac{1}{g}$, eq. 46)	Transient aphids bear the disease from outside the system. Resident and transient aphids spread the disease.

* The disease is always able to persist, regardless of whether the basic reproduction number is smaller or larger than 1.

S5 Agricultural practices and disease control

The responses of the incidence of virus infection in plants ($\bar{I}$) and of the basic reproduction number (R_0) to variation of plant hosting capacity (h), aphid mortality (μ) and infected plant roguing rate (ρ) are reported in Fig. S2. Details on the involved processes are given in the main text.

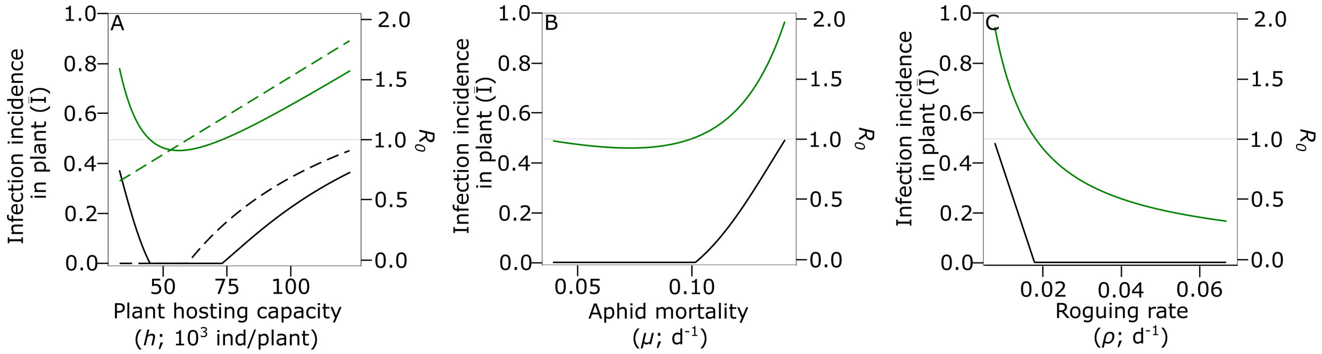

Figure S2: Response of the incidence of virus infection in plant at the equilibrium ($\bar{I}$, in black) and of the reproduction number (R_0, in green) to changes in (A) aphids hosting capacity (h) under indirect (continuous lines) and direct (dashed lines) interference scenarios; (B) resident aphids mortality (μ); (C) roguing rate (ρ).

S6 Influence of interference parameters on results

We explored the responses of R_0 to variation of plant hosting capacity (h), aphid mortality (μ) and infected plant roguing rate (ρ) under three scenarios of interference strength, corresponding to three values of the interference strength parameter ($\nu = 2$, $\nu = 12$, $\nu = 22$). Similarly, we explored the response of R_0 to variation of parameters h, μ and ρ under three scenarios of interference curvature, corresponding to three values of the curvature parameter ($\alpha = 0.5$, $\alpha = 1$ and $\alpha = 1.5$). Results are showed in Figs. S3 and S4, respectively. The results presented in the main text, corresponding to parameter values $\nu = 12$ and $\alpha = 1$, are shown in the second row of Figs. S3 and S4. The responses of R_0 to variations of h, μ and ρ are generally qualitative unaffected by the value of ν and α. The only difference is the response of R_0 to variation in aphid mortality for $\nu = 2$ (Fig. S3 B) and $\alpha = 0.5$ (Fig. S4 B). Here, the response of R_0 is monotone, in contrast to the results showed in the main text. In this case, the interference exerted by resident aphids is so low that, even for small value of resident aphids mortality, the virus is mainly transmitted by the transient vector. However, we note that if the values of other parameters were altered, for example to increase the density of resident aphids by increasing the plant hosting capacity h, then non-monotonicity would once again be seen. Nevertheless, the general finding that increasing pesticides could be counter productive in reducing NPT viruses is still valid.

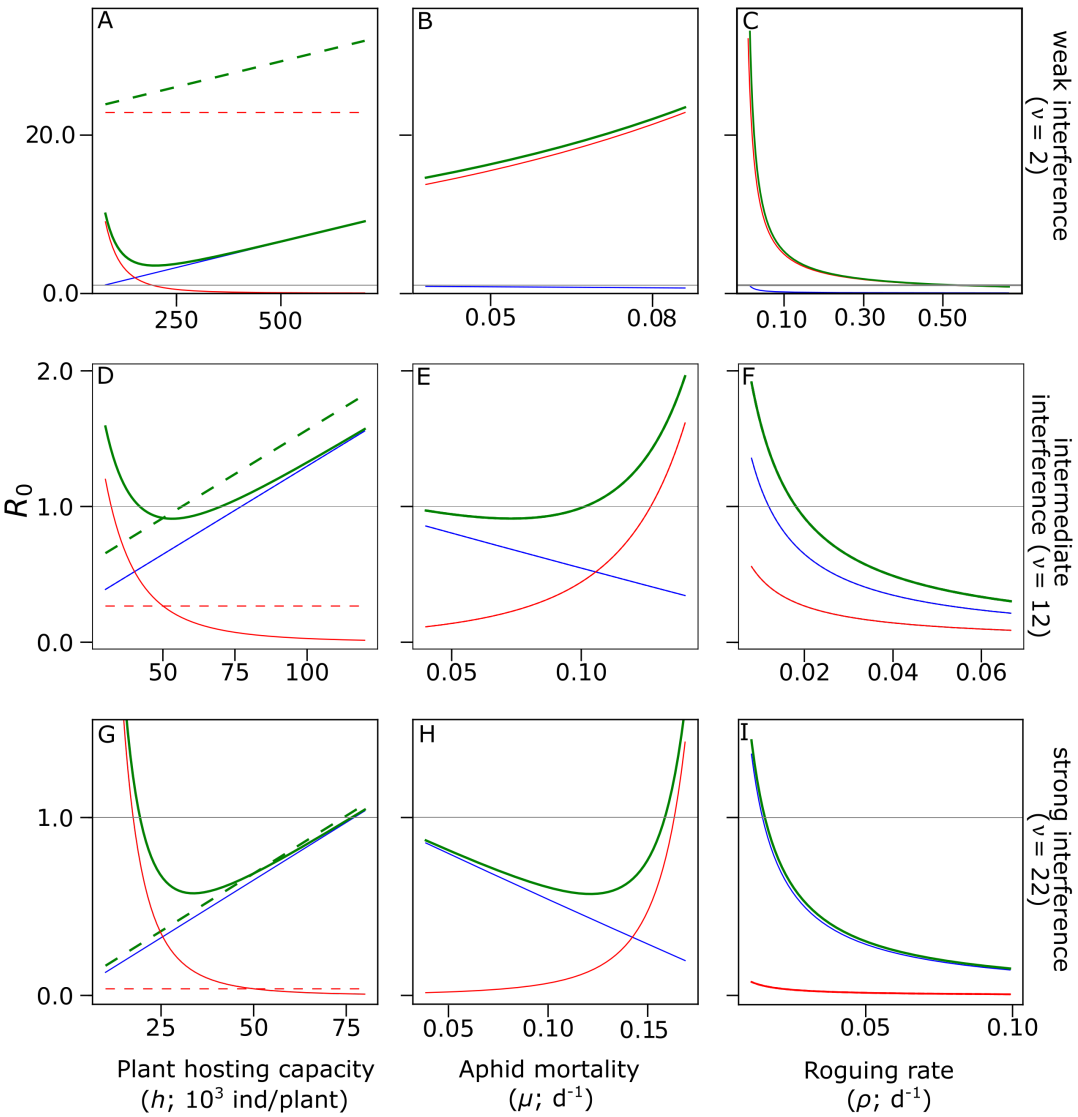

Figure S3: Influence of interference strength parameter (ν) on the response of the basic reproduction number R_0 (in bold and green) and its components R_0^R (in blue) and R_0^T (in red) to changes in (A, D, G) plant hosting capacity (h) under indirect (continuous line) and direct (dashed line) interference scenarios, (B, E, H) resident aphids mortality (μ), (C, F, I) roguing rate (ρ). Note that in (A, D, G) blue continuous and dashed lines overlap, in (C) green and red continuous lines overlap and in (I) green and blue continuous lines overlap.

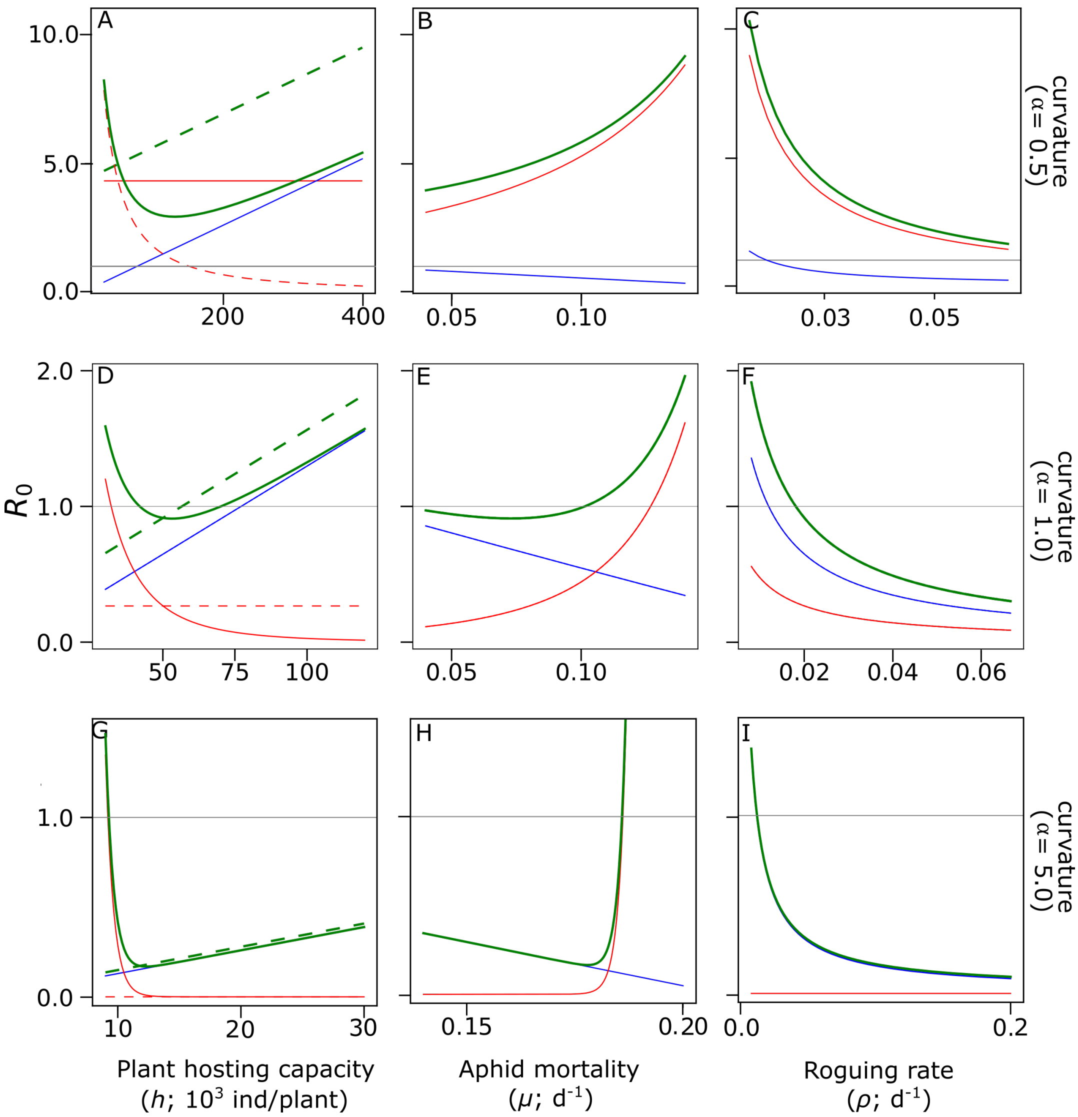

Figure S4: Influence of the interference curvature parameter (α) on the response of the basic reproduction number R_0 (in bold and green) and its components R_0^R (in blue) and R_0^T (in red) to changes in (A, D, G) plant hosting capacity (h) under indirect (continuous line) and direct (dashed line) interference scenarios, (B, E, H) resident aphids mortality (μ), (C, F, I) roguing rate (ρ). Note that in (A, D, G) blue continuous and dashed lines overlap, in (G) green continuous and dashed lines and blue continuous and dashed lines overlap for $h > 12000$ ind/plant (green dashed line is slightly moved up to improve visualization), and in (I) green and blue continuous lines overlap.

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[2] Heesterbeek J, Roberts M. The type-reproduction number T in models for infectious disease control. Mathematical biosciences. 2007;206(1):3–10.