Supplementary information

SI. 1 The computation of the photoperiod

Photoperiod (P), expressed as the fraction of a day (i.e. a 24-hour period), during which a plant is exposed to light, at the ordinal date t (calculated from the 1st January of a given year as reference date) is computed as:

$$P(t) = a \sin\left(2\pi \cdot \frac{t+b}{365}\right) + c \qquad (1)$$

where a = 0.14 d, b = -80.75 d and c = 0.5 d can be estimated for any location when knowing the values of maximum and minimum P, respectively P_{MAX} and P_{MIN}, and the date of their occurrence. In the case of Avignon (southern France, 43° 57' N), P_{MAX} = 0.64 d and P_{MIN} = 0.36 d, respectively occurring the 22nd of June and of December.

Variation in time of P is then computed from the derivative of eq.1:

$$\dot{P} = \frac{2\pi a}{365} \cdot \cos\left(2\pi \cdot \frac{t+b}{365}\right) \qquad (2)$$

SI 2 Allometric relationships to compute fresh fruit mass;

Fruit fresh mass m_{FF} of a fruit is computed as

$$m_{FF}(t) = \delta_1 m_F + \delta_2 m_F^2 \qquad (3)$$

where m_F is the fruit carbon mass. Such a function considers that bigger fruits have a bigger proportion of water so that fresh fruit mass increases more than linearly with carbon fruit mass. We obtained estimates of β = 1.69 10^{-2} m^2 gC^{-1}, γ = 0.48, d_1 = 11.53 gC^{-1} and d_2 = 0.25 gC^{-2} by regressions on field data collected in 2013 from an experimental orchard of 17 late-maturing peach trees (cv. Suncrest/GF677) planted in 1998 at the INRA station of Avignon (southern France, 43°60' N, 4°49' E).

SI. 3 The model initialization for calibration and validation

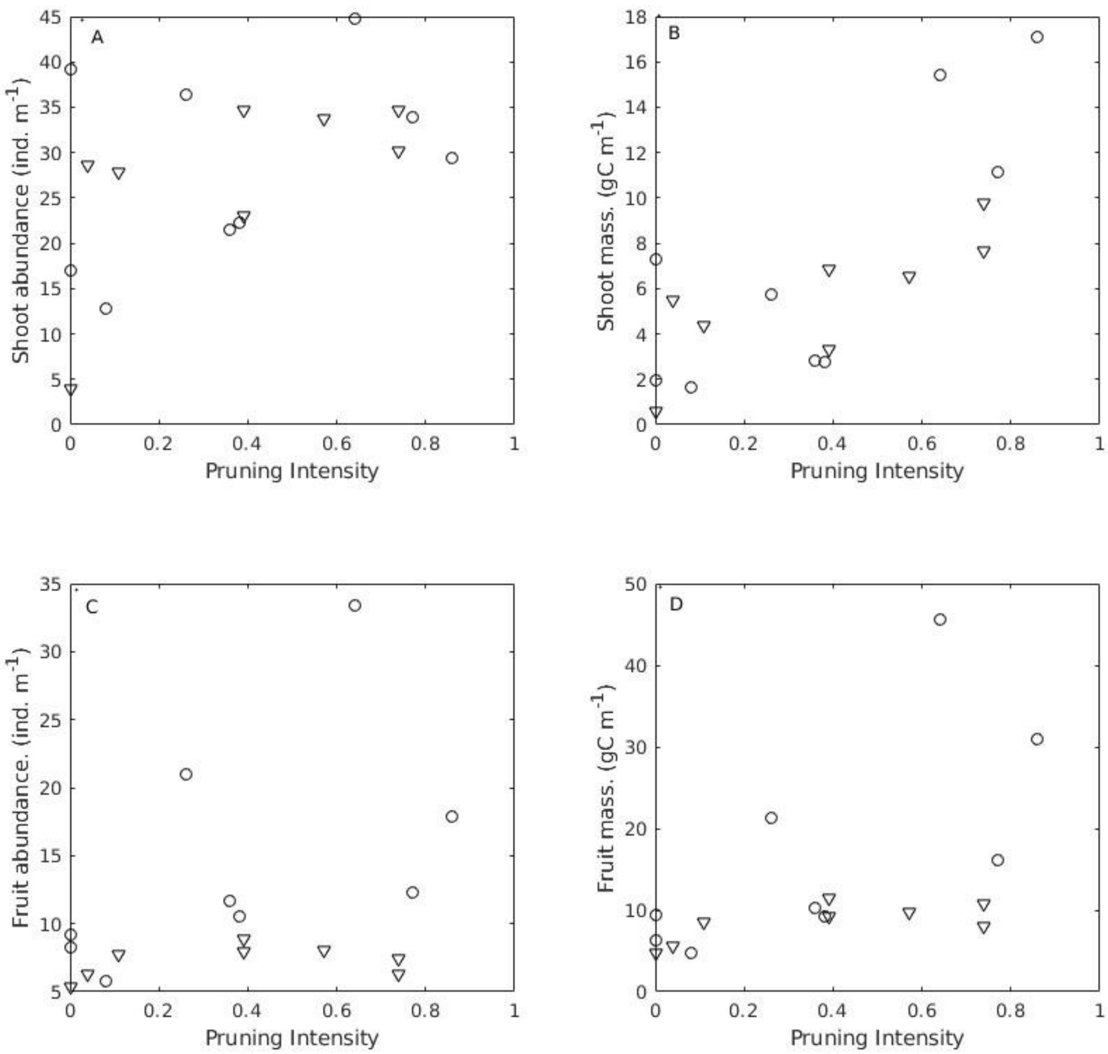
Table S1: Main features of the 17 peach *Prunus persica* plants observed and used to calibrate and validate the model. One year old branch after winter pruning (W), pruning intensity (PI), thinning intensity (TI), number of shoots (n_S) and fruits (n_F) and initial values of the model state variables (C, S, R, F) at t_0 = 147.

Plant	W (m)	PI	TI	n_S	n_F	C_0 (gC) †	S_0 (gC)	R_0 (gC) ‡	F_0 (gC)
1	20.9	0.77	0	711	257	0	234	44	336
2	87	0	0	3411	802	0	633	42	823
3	43.7	0.26	0	1588	916	0	251	28	931
4	11.8	0.86	0	354	210	0	201	40	364
5	84.5	0.36	0	1810	989	0	238	63	864
6	162	0	0	2751	1345	0	316	77	1024
7	30.2	0.64	0	1355	1010	0	466	41	1376
8	66.3	0.38	0	1472	701	0	183	51	617
9	151.8	0.8	0	1938	872	0	250	79	717
10	156	0	0.5	618	834	0	91	75	747
11	91.7	0.11	0.5	2559	713	0	404	49	789
12	16.7	0.74	0.5	577	123	0	128	31	179
13	73.2	0.39	0.5	1684	648	0	243	57	842
14	51.2	0	0.5	1780	408	0	351	40	473
15	126	0.4	0.5	3637	797	0	697	63	720
16	28.1	0.74	0.5	849	176	0	274	52	226
17	60.2	0.57	0.5	2034	483	0	395	67	591

† We arbitrarily set C_0 = 0 by assuming that at time t_0 the plant stops relying on previous year carbon resources and uses newly photosynthesised carbon; ‡ We assumed that initial root mass is in optimal equilibrium μ with the shoot mass that the plant would have in absence of pruning. We thus computed $R_0 = \mu \cdot \zeta \cdot W/(1-PI)$, where ζ = 2.2 gC m^{-1} is the shoot mass per unit of *W* extrapolated from linear regression on field data (Fig. 1SI) for PI=0.

SI. 4 The experimental data-set

Fig. S1 Observed shoot abundance (A), total shoot mass (B), fruit abundance (C) and total fruit mass (D) per unit of 1-yr old branch, at t_0 = 147 d. Values come from peach *Prunus persica* trees subject to different winter pruning intensities, that underwent to fruit thinning (triangles) or not (circles).



SI. 5 The model initialization for simulating virtual management scenarios

For the virtual plant we set 1-yr old branch before pruning W_{PRE} = 150 m and $W = W_{PRE}(1 - PI)$ is the quantity of 1-yr old branch bearing fruits and shoots in the growing season in a plant subject to a given pruning intensity (PI). We computed the number of shoots and of fruits per tree as $n_S = \tau_S \cdot W$ and

$n_F = \tau_F \cdot (1 - TI) \cdot W$ where τ_S and τ_F are respectively the number of shoots and fruits (in absence of fruit thinning) per unit of 1-yr old branch and TI is the thinning intensity varying from 0 to 1. We thus set initial values of the model state variables as:

$$\begin{cases} C_0 = 0 \\ S_0 = \omega_S \cdot W \\ R_0 = \mu \cdot \zeta \cdot W (1 - PI)^{-1} \\ F_0 = \omega_F \cdot (1 - TI) \cdot W \end{cases} \tag{4}$$

where ω_S is the mass of shoots and ω_F is the mass of fruits (in absence of fruit thinning) per unit of 1 yr old branch. We estimated values of τ_S, τ_F, ω_S, ω_S from field data reported in Fig. 1SI. The linear regression of τ_S against PI indicates that τ_S does not significantly vary with PI ($F_{1,15} = 4.67$, $P = 0.05$); we then set $\tau_S = 28$ ind. m^{-1}. The linear regression of τ_F against W, in absence of fruit thinning, indicates that τ_F does not significantly vary with PI ($F_{1,7} = 2.87$, $P = 0.13$); we then set $\tau_F = 14$ ind. m^{-1}. The linear regression of ω_S against PI indicates that ω_S varies with PI ($F_{1,15} = 19.34$, $P < 0.01$); we then set $\omega_S = 2.2 + 12PI$. The linear regression of ω_S, in absence of fruit thinning, against PI indicates that ω_S does not significantly vary with PI ($F_{1,7} = 6.18$, $P = 0.04$); we then set $\omega_F = 17$ gC m^{-1}.

To evaluate the sensitivity of the model to perturbations of the parameters, we set PI = 0.5 and TI = 0.72. To evaluate the consequences of different combinations of PI ad TI we varied them between 0 and 0.95. Note that pruning and thinning intensities both equal to zero exemplifies the extreme ("wild") case in which no management action is taken, while a 50% pruning plus a 72% (fruit load of ca. 4 ind. m^{-1}) thinning represents a common cultural practice in commercial peach orchards (Bussi and Génard, 2014)

SI. 6 Results

Fig. S2 A) Photoperiod (P), B) photoperiod variation $\dot{P}$ and C) factor σ_S controlling shoot and root growth (eqn. 6 computed for values of $\eta_S = 3.82\ 10^{-2}$ d s^{-1} and λ_S = - 57 s d^{-1}).

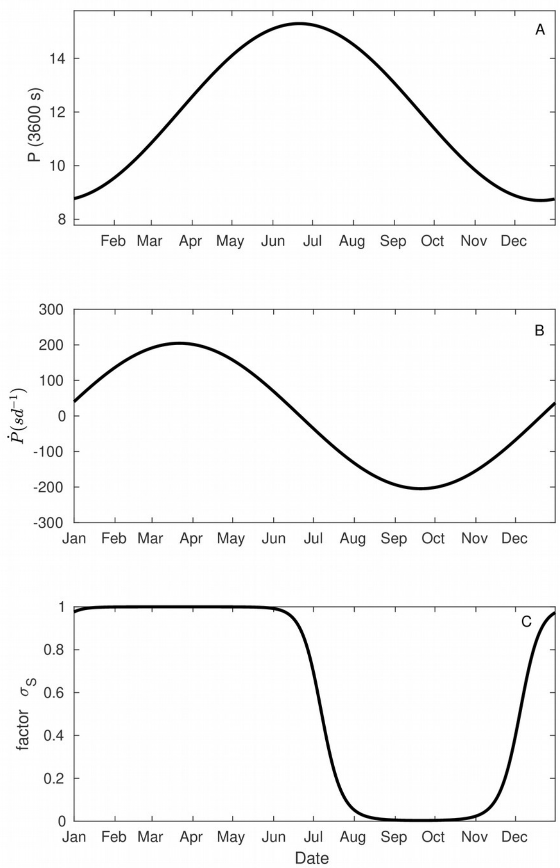


Fig. S3. Predicted variation of carbon concentration in leaves (A) and root:shoot ratio (B) over time. Values refer to to 17 peach trees 'cv. Suncrest/GF677' subject to different branch pruning and fruit thinning intensities (see the *Case study* section). Continuous and dotted lines represent median and 90% CI of model simulations.

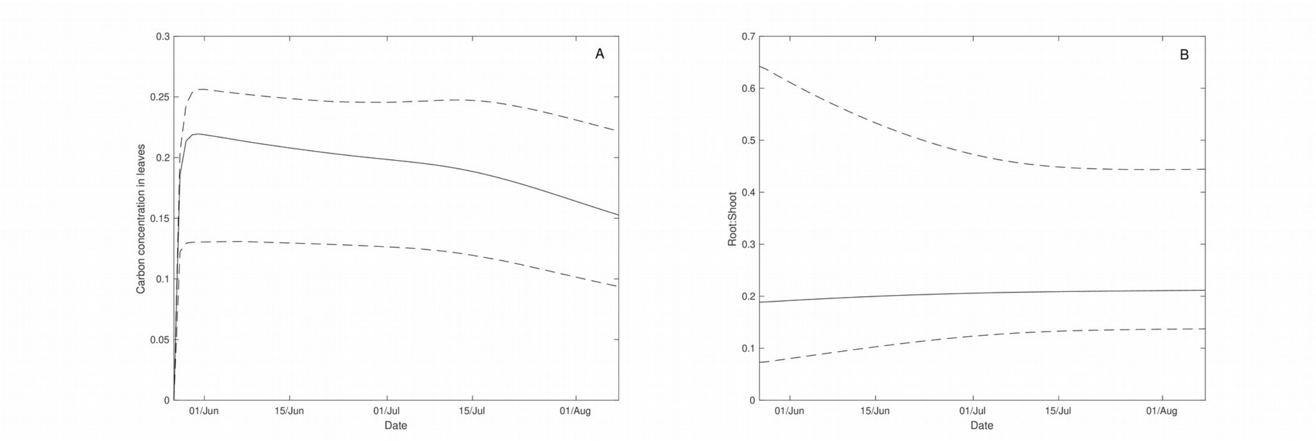


Fig. S4. Simulated variation of A) total root and B) total non structural carbon, at the end of the growing period, in response to a variation in the *i*) photosynthetic rate, ϕ_C, *ii*) optimal root:shoot balance, μ , *iii*) shoot and root growth rate, α_S and *iv*) fruit growth rate, α_F. Simulations refer to a virtual peach *Prunus persica* plant (see main text for details). Reference parameter values are reported in table 1 and reference mass of root and non-structural carbon compartment is respectively 243 and 215 gC.

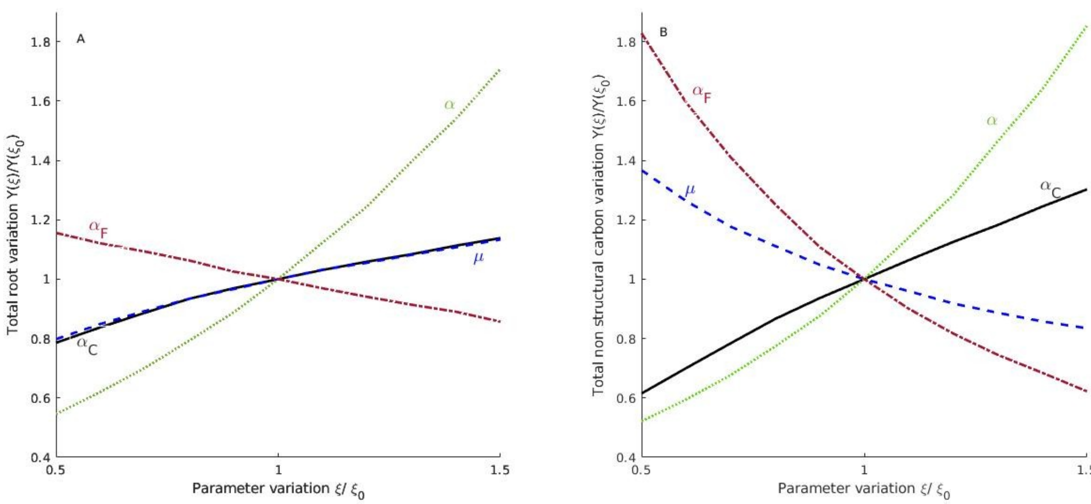
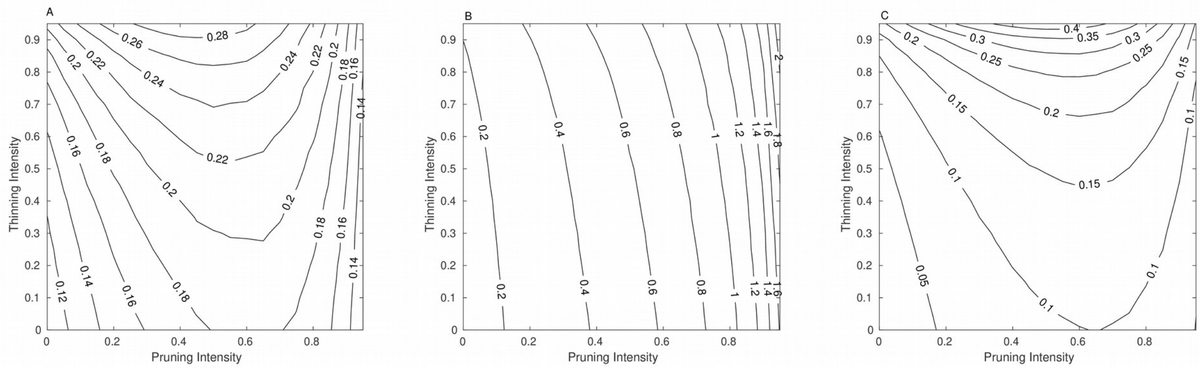


Fig. S5. Simulated A) total root in kgC, B) average shoot in gC, and C) total non-structural carbon in kgC, at the end of the growing period, for different combinations of pruning and thinning intensities. Simulations refer to a virtual peach *Prunus persica* plant (see main text for details).



References

Bussi, C. and Génard, M. (2014) 'Thinning and pruning to overcome alternate bearing in peach trees', *European Journal of Horticultural Science*, 79(6), pp. 313–317.