3. Biomass

Leaves grow at each time step. At cycle *n* the quantity of biomass given to organs (supply) is the biomass available at cycle *n-1*. At each cycle, the supply increases because the number of organs increases. However if the supply at cycle *n-1* is constant, the size of each organ produced over time will decrease.

The relationship between the produced biomass *Q(n)* at cycle *n* and the supply *Q(n-1)* at cycle *n-1* is:

$$\boxed{Q(n) = \frac{E(n)}{r\,e} N_a(n)\, p_a \frac{Q(n-1)}{D(n)}} \qquad (1)$$

Demonstration

$$Q(n) = \frac{E(n)}{r} S(n) \qquad (2)$$

$Q(n)$ = supply at n cycle = biomass that can be produced at n cycle

$E(n)$ = environment efficiency at n cycle (e.g. light or water availability)

r = leaves resistance to environment or conversion coefficient of environment efficiency in carbon RUE or WUE or ETP) = coefficient of supply calibration which is given by experiments

$S(n)$ = total efficient foliar surface produced at n cycle

but $$S(n) = N_a(n) \cdot s(n) \qquad (3)$$

$N_a(n)$ = total number of leaves produced at n cycle (a indicates assimilating organ)

$s(n)$ = elementary surface of a leaf produced at n cycle

$$s(n) = \frac{q_a(n)}{e} \qquad (4)$$

$q_a(n)$ = volume of a leaf produced at n cycle = demand of leave at n cycle

e = thickness of a leaf

$$q_a(n) = p_a \frac{Q(n-1)}{D(n)} \qquad (5)$$

p_a = sink strengh of a leaf = demand of a leaf

$Q(n-1)$ = total supply of biomass at $n-1$ cycle

$D(n)$ = total demand of organs at n cycle

Taking equation (2) we have

$$Q(n) = \frac{E(n)}{r} S(n) = \frac{E(n)}{r} N_a(n) \frac{p_a \dfrac{Q(n-1)}{D(n)}}{e}$$

Then during free growth we have the following equation:

$$Q(n) = \frac{E(n)}{r\,e} N_a(n)\, p_a \frac{Q(n-1)}{D(n)}$$

Let $$A = r\,e \frac{D(n)}{N_a(n)\, p_a} \qquad (6)$$

In the simple case where the plant is made of leaves and internodes, the demand at cycle n is:

$$D(n) = N_a(n)\, p_a + N_e(n)\, p_e \qquad (7)$$

$N_e(n)$ = total number of internodes produced at cycle n

p_e = sink strength of the internode = demand of the internode

If each internode produces one leaf at each time step we have: $N_a(n) = N_e(n)$, then

$D(n) = N_a(n)\,(p_a + p_e)$

$$A = r\,e \frac{N_a(n)\,(p_a + p_e)}{N_a(n)\, p_a} = r\,e \frac{p_a + p_e}{p_a}$$

This relationship links leaves allometry (thickness e), the environment efficiency (r) and the ratio of sink strengths. By recurrence we obtain

$$Q(n) = \frac{E(n)}{A} Q(n-1) = \left(\frac{E(n)}{A}\right)^n Q_0 \qquad \text{(1bis)}$$

if $N_a(n) = N_e(n)$

We can note that the number of phytomers does not influence $Q(n)$ so that $Q(n)$ does not depend on the architectural model.

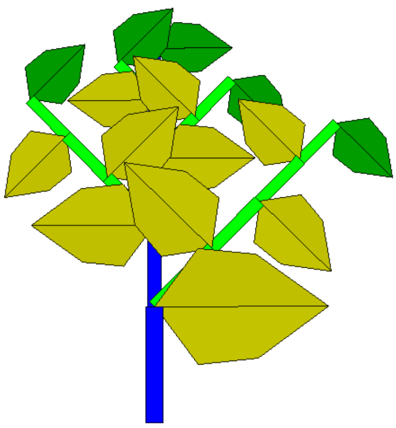

Figure 5. *Roux models*

with and without biomass