SUPPLEMENTARY DATA

(A) Description of the root architectures of maize, bean and squash

Maize root architecture

Among the 'three sisters', maize has the largest number of different root classes and develops the greatest total root length, nearly twice as much as bean and squash (Figures 1,2). The root length advantage of maize can already be observed at 8 days after germination (Blamey *et al.*, 1992), when maize still has the smallest shoot. At this stage the maize root system is still relatively simple with a primary root and 2-6 seminal roots, but towards the end of the second week after germination, nodal roots start to appear which eventually will dominate the root system. The nodal root system is fast growing and relatively steep and can overtake the seminal root system in depth (Jaramillo-Velastegui, 2011). The nodal root system is formed by successive whorls of roots. Later whorls have more and thicker roots that, depending on the genotype, may be less steep. The first 3-5 whorls are formed belowground. After 4-6 weeks the first aboveground whorls may appear (brace roots). At this stage the maize root system is characterized by many axial roots of varying diameter. Many lateral roots, on average 9 cm^{-1} (Trachsel, University Park, unpublished), grow from these axial roots with longer and thicker laterals growing of thicker axial roots. Stronger developed lateral roots can have tertiary laterals. Maize has, like most monocotyledons, no secondary growth, which may explain the continued development of new axial roots of increasing thickness.

Common Bean root architecture

The root system of common bean (Figure 1) consists of one primary root and 2-14 basal roots organized in whorls of 4 roots (Basu *et al.*, 2007). These whorls start forming at 1 or 2 days after germination and are all positioned close together at the base of the hypocotyl. The basal roots stay very shallow in some genotypes, but grow deep in others (Liao *et al.*, 2004). Both the primary root and the

basal roots from laterals of variable length 4-20 cm length at a branching frequency of 12 and 7 laterals.cm^{-1} respectively (Zhang *et al.*, University Park, unpublished). During the second week after germination the belowground section of the hypocotyl forms hypocotyl-borne roots, commonly termed 'adventitious roots' (Miller *et al.*, 2003; Ochoa *et al.*, 2006; Walk *et al.*, 2006). Hypocotyl-borne roots are relatively fine roots with short laterals that explore the top 5 cm of the soil. The development of hypocotyl-borne roots varies strongly across genotypes and environments (Ochoa *et al.*, 2006). The major axes and strongly developed laterals have secondary development, which may increase the thickness of the roots multiple times. Nutrient deficient bean plants have etiolated roots (Lynch, 2007, 2011), which means that secondary thickening is reduced in favor of primary root growth.

Pepo squash root architecture

Pepo squash forms a relatively simple herringbone root system characterized by a strongly developed primary root with infrequent (2 cm^{-1}) but long laterals (Figure 1, Fita *et al.*, 2008). Some of these laterals can grow up to a meter in length (Harrison-Murray and Clarkson, 1973) and form secondary laterals that may form tertiary laterals. These high branching orders cause squash to have many fine roots close together (Figure 3). Most of the long primary laterals are positioned closer to the base of the primary root and fewer long primary laterals are formed deeper in the soil (Weaver and Bruner, 1927; Harrison-Murray and Clarkson, 1973). These long laterals often grow at near horizontal angles (Weaver and Bruner, 1927). The primary root and long laterals have strong secondary development. Based on the low branching density of lateral roots and the short length of fine laterals we concluded that squash has relatively to its shoot a short root system (Figure 2). Increasing the root length of squash in the model would require us to use parameters outside the range that we measured. Furthermore, this conclusion is supported by measurements of the root length density in cores taken in field-grown squash (Zhang *et al.*, University Park, unpublished) and by the relative measurements of root length of maize bean and squash in a hydroponics study (Blamey *et al.*, 1992). At 6 weeks after germination, the

shoot of an individual squash plant may be 4 times larger than that of a bean plant, but the root system may be similar in length. However, the total soil volume that a squash root system explores may be rather extensive early on as the long laterals spread wide (Figure 1). Consequently, the distance between squash roots to other plants is greater than that of the other crops (Figure 3). Similarly to the spread out laterals, squash vines above ground spread out across the soil surface. These vines form adventitious roots at the nodes when a node is in touch with moist soil. In our experiments (Zhang *et al.*, University Park, unpublished) most vines did not form adventitious roots. Therefore we did not study the architecture of these adventitious roots.

References

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Weaver JE, Bruner WE. **1927**. *Root development of vegetable crops*. New York, USA: McGraw-hill book company.

(B) *SimRoot* Parameterization

SimRoot uses a hierarchical xml formatted input file which is graphically presented below. The hierarchy gives the parameters context. For example, the parameter 'specific leaf area' belongs to the shoot of a specific plant. In *SimRoot* parameters can be a single value, a value drawn from a distribution, or the result of an interpolation table. The text below is also provided as a separate .rtf file.

1 'environment'

1.1 'atmosphere'

1.1.1 'evaporation' (cm) =f{'time'} (day) x,y pairs :{ 0 0 1 0.05 2 0.1 3 0.1 4 0.05 5 0.05 6 0.1 7 0.05 8 0.05 9 0.1 10 0.1 11 0.05 12 0.1 13 0.1 14 0.05 15 0.04 16 0.03 17 0.02 18 0.09 19 0.09 20 0.04 21 0.09 22 0.09 23 0.04 24 0.03 25 0.02 26 0.02 27 0.08 28 0.03 29 0.08 30 0.03 31 0.08 32 0.07 33 0.07 34 0.07 35 0.03 36 0.02 37 0.01 38 0 39 0 40 0 41 0 42 0.06 }
1.1.2 'irradiation' = 4000 (uMol/cm2/day)
1.1.3 'precipitation' (cm) =f{'time'} (day) x,y pairs :{ 0 0 1 0 2 1 3 0.29 4 0 5 0 6 0.61 7 0 8 0 9 0.25 10 0.03 11 0 12 0.64 13 0.33 14 0 15 0 16 0 17 0 18 1.8 19 0.2 20 0 21 2.84 22 0.38 23 0 24 0 25 0 26 0 27 0.18 28 0 29 0.46 30 0 31 1.35 32 0.13 33 0.23 34 0.25 35 0 36 0 37 0 38 0 39 0 40 0 41 0 42 1.42 }

1.2 'dimensions'

1.2.1 'max corner' = 30 0 34 (cm)
1.2.2 'min corner' = -30 -150 -26 (cm)

1.3 'soil'

1.3.1 'bulk density' (g/cm3) =f{'depth'} (cm) x,y pairs :{ -200 1.51 -65 1.51 -47 1.4 -30 1.42 -16 1.29 -5 1.24 0 1.24 }
1.3.2 'nitrate'

1.3.2.1 'adsorption coefficient' = 0 (uMol/cm)
1.3.2.2 'buffer power' (noUnit) =f{'depth'} (cm) x,y pairs :{ -1000 0.4 1000 0.4 }
1.3.2.3 'concentration' (uMol/ml) =f{'depth'} (cm) x,y pairs :{ -1000 1.59 -55 1.59 -45 1.67 -35 2.17 -25 3.15 -15 4.02 -5 2.36 0 2.8 0.01 0 100 0 }
1.3.2.4 'diffusion coefficient' (cm2/day) =f{'depth'} (cm) x,y pairs :{ -1000 0.216 -0 0.216 1e-05 1e-08 1000 1e-08 }
1.3.2.5 'longitudinal dispersivity' = 1 (cm)
1.3.2.6 'r1-r0' = 4 (cm)
1.3.2.7 'saturated diffusion coefficient' = 1.6416 (cm2/day)
1.3.2.8 'transverse dispersivity' = 0.5 (cm)

1.3.3 'organic'

1.3.3.1 ' C/N ratio microbes' = 10 (g/g)
1.3.3.2 'C/N ratio' (g/g) =f{'depth'} (cm) x,y pairs :{ -10000 13 0 13 }
1.3.3.3 'assimilation efficiency microbes' = 1 (noUnit)
1.3.3.4 'carbon content' (g/g) =f{'depth'} (cm) x,y pairs :{ -200 0.005 -40 0.005 -30 0.01 -10 0.02 0 0.02 }
1.3.3.5 'initial relative mineralisation rate' (g/g/year) =f{'depth'} (cm) x,y pairs :{ -1000 0 -25 0 -10 0.037 0 0.037 }
1.3.3.6 'speed of aging' = 0.46 (noUnit)
1.3.3.7 'time offset' = 30 (day)

1.3.4 'phosphorus'

1.3.4.1 'adsorption coefficient' = 400 (uMol/cm)
1.3.4.2 'buffer power' (noUnit) =f{'depth'} (cm) x,y pairs :{ -1000 400 1000 400 }
1.3.4.3 'concentration' (uMol/ml) =f{'depth'} (cm) x,y pairs :{ -1000 0.00024 -30 0.00025 -29 0.00175 0 0.00175 0.0001 0 1000 0 }
1.3.4.4 'diffusion coefficient' (cm2/day) =f{'depth'} (cm) x,y pairs :{ -1000 0.00019872 -0 0.00019872 1000 0.00019872 }
1.3.4.5 'longitudinal dispersivity' = 1 (cm)
1.3.4.6 'r1-r0' = 0.3 (cm)
1.3.4.7 'saturated diffusion coefficient' = 0.094 (cm2/day)
1.3.4.8 'transverse dispersivity' = 0.5 (cm)

1.3.5 'potassium'

1.3.5.1 'adsorption coefficient' = 10 (uMol/cm)
1.3.5.2 'buffer power' (noUnit) =f{'depth'} (cm) x,y pairs :{ -1000 10 1000 10 }
1.3.5.3 'concentration' (uMol/ml) =f{'depth'} (cm) x,y pairs :{ -1000 0.05 -30 0.05 -29 0.15 0 0.15 1e-05 0 1000 0 }
1.3.5.4 'diffusion coefficient' (cm2/day) =f{'depth'} (cm) x,y pairs :{ -1000 0.0143 -0 0.0143 1000 0.0143 }
1.3.5.5 'longitudinal dispersivity' = 1 (cm)
1.3.5.6 'r1-r0' = 1.5 (cm)
1.3.5.7 'saturated diffusion coefficient' = 1.56 (cm2/day)
1.3.5.8 'transverse dispersivity' = 0.5 (cm)

1.3.6 'water'

1.3.6.1 'initial hydraulic head' (cm) =f{'depth'} (cm) x,y pairs :{ -200 0 -151 -50 -50 -150 -45 -155 -40 -160 -35 -165 -30

-170 -25 -175 -20 -180 -15 -190 -10 -200 -5 -220 -2 -240 -1 -300 -0 -400 }
1.3.6.2 'residual water content' (100%) =f{'depth'} (cm) x,y pairs :{ -300 0.067 0 0.067 }
1.3.6.3 'saturated conductivity' (cm/day) =f{'depth'} (cm) x,y pairs :{ -300 10.8 0 10.8 }
1.3.6.4 'saturated water content' (100%) =f{'depth'} (cm) x,y pairs :{ -300 0.39 -65 0.39 -35 0.39 -25 0.43 -15 0.45 0 0.46 }
1.3.6.5 'van genuchten:alpha' (noUnit/cm) =f{'depth'} (cm) x,y pairs :{ -300 0.02 0 0.02 }
1.3.6.6 'van genuchten:n' (noUnit) =f{'depth'} (cm) x,y pairs :{ -300 1.41 0 1.41 }
1.3.6.7 'volumetric water content in barber cushman' = 0.3 (cm3/cm3)

2 'root type parameters'

2.1 'maize'

2.1.1 'braceroots'

2.1.1.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.11 1000 0.11 }
2.1.1.2 'bottom boundary' = 1 (noUnit)
2.1.1.3 'bounce of the side' = 1 (noUnit)
2.1.1.4 'branch list'

2.1.1.4.1 'lateral of crown roots'

2.1.1.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.1.4.1.2 'branching frequency' (cm) minimum=0.1 maximum=0.3
2.1.1.4.1.3 'branching spatial offset' = 12 (cm)
2.1.1.4.1.4 'length root tip' = 10.93 (cm)
2.1.1.4.1.5 'number of branches/whorl' = 1 (#)

2.1.1.5 'branching angle' = 140 (degrees)
2.1.1.6 'density' = 0.094 (g/cm3)
2.1.1.7 'diameter' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0.223 7 0.145 100 0.145 }
2.1.1.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.1.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0 }
2.1.1.10 'length root tip without xylem vessels' = 2 (cm)
2.1.1.11 'longitudinal growth rate multiplier' (cm) minimum=0.7 maximum=1
2.1.1.12 'nitrate'

2.1.1.12.1 ' Cmin' = 0.001 (uMol/ml)
2.1.1.12.2 ' Imax' (uMol/cm2/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.21 2 2.1 40 2.1 }
2.1.1.12.3 ' Km' (uMol/ml) =f{'time since creation'} (day) x,y pairs :{ 0 0.0157 2 0.0522 40 0.0522 }
2.1.1.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.1.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.1.13 'number of xylem poles' = 40 (noUnit)
2.1.1.14 'phosphorus'

2.1.1.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.1.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.1.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.1.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.1.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.1.15 'potassium'

2.1.1.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.1.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.1.15.3 ' Km' = 0.014 (uMol/ml)
2.1.1.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.1.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.1.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.1.1.17 'regular topology' = 4 (noUnit)
2.1.1.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 5e-06 }
2.1.1.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.1.20 'root class ID' = 102 (noUnit)
2.1.1.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.1.22 'root hair diameter' = 0.0005 (cm)
2.1.1.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.1.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.1.1.25 'top boundary' = 1 (noUnit)

2.1.2 'braceroots2'

2.1.2.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.11 1000 0.11 }
2.1.2.2 'bottom boundary' = 1 (noUnit)

2.1.2.3 'bounce of the side' = 1 (noUnit)
2.1.2.4 'branch list'

2.1.2.4.1 'lateral of crown roots'

2.1.2.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.2.4.1.2 'branching frequency' (cm) minimum=0.1 maximum=0.4
2.1.2.4.1.3 'branching spatial offset' = 15 (cm)
2.1.2.4.1.4 'length root tip' = 10.93 (cm)
2.1.2.4.1.5 'number of branches/whorl' = 1 (#)

2.1.2.5 'branching angle' = 130 (degrees)
2.1.2.6 'density' = 0.094 (g/cm3)
2.1.2.7 'diameter' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0.253 7 0.175 100 0.175 }
2.1.2.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.2.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0 }
2.1.2.10 'length root tip without xylem vessels' = 2 (cm)
2.1.2.11 'longitudinal growth rate multiplier' (cm) minimum=0.7 maximum=1
2.1.2.12 'nitrate'

2.1.2.12.1 ' Cmin' = 0.001 (uMol/ml)
2.1.2.12.2 ' Imax' (uMol/cm2/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.21 2 2.1 40 2.1 }
2.1.2.12.3 ' Km' (uMol/ml) =f{'time since creation'} (day) x,y pairs :{ 0 0.0157 2 0.0522 40 0.0522 }
2.1.2.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.2.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.2.13 'number of xylem poles' = 48 (noUnit)
2.1.2.14 'phosphorus'

2.1.2.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.2.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.2.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.2.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.2.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.2.15 'potassium'

2.1.2.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.2.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.2.15.3 ' Km' = 0.014 (uMol/ml)
2.1.2.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.2.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.2.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.1.2.17 'regular topology' = 3 (noUnit)
2.1.2.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 5e-06 }
2.1.2.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.2.20 'root class ID' = 102 (noUnit)
2.1.2.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.2.22 'root hair diameter' = 0.0005 (cm)
2.1.2.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.2.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.1.2.25 'top boundary' = 1 (noUnit)

2.1.3 'finelateral'

2.1.3.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.1.3.2 'bottom boundary' = 1 (noUnit)
2.1.3.3 'bounce of the side' = 1 (noUnit)
2.1.3.4 'branch list'

2.1.3.4.1 'finelateral2'

2.1.3.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.3.4.1.2 'branching frequency' (cm) minimum=0.4 maximum=0.6
2.1.3.4.1.3 'length root tip' = 1.5 (cm)

2.1.3.5 'branching angle' = 62.83 (degrees)
2.1.3.6 'density' = 0.094 (g/cm3)
2.1.3.7 'diameter' = 0.025 (cm)
2.1.3.8 'gravitropism.v2' = 0 0 0 (cm)
2.1.3.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 1 0.35 6 0 1000 0 }
2.1.3.10 'length root tip without xylem vessels' = 2 (cm)
2.1.3.11 'longitudinal growth rate multiplier' (cm) minimum=0.5 maximum=1.5 mean=1 stdev=0.1

2.1.3.12 'nitrate'

2.1.3.12.1 ' Cmin' = 0.0017 (uMol/ml)
2.1.3.12.2 ' Imax' = 1.27 (uMol/cm2/day)
2.1.3.12.3 ' Km' = 0.0027 (uMol/ml)
2.1.3.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.3.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.3.13 'number of xylem poles' = 4 (noUnit)
2.1.3.14 'phosphorus'

2.1.3.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.3.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.3.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.3.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.3.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.3.15 'potassium'

2.1.3.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.3.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.3.15.3 ' Km' = 0.014 (uMol/ml)
2.1.3.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.3.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.3.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 1 1 }
2.1.3.17 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 1e-06 }
2.1.3.18 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.3.19 'root class ID' = 98 (noUnit)
2.1.3.20 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.3.21 'root hair diameter' = 0.0005 (cm)
2.1.3.22 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.3.23 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.1.3.24 'top boundary' = 1 (noUnit)

2.1.4 'finelateral2'

2.1.4.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.1.4.2 'bottom boundary' = 1 (noUnit)
2.1.4.3 'bounce of the side' = 1 (noUnit)
2.1.4.4 'branch list'
2.1.4.5 'branching angle' = 62.83 (degrees)
2.1.4.6 'density' = 0.094 (g/cm3)
2.1.4.7 'diameter' = 0.015 (cm)
2.1.4.8 'gravitropism.v2' = 0 0 0 (cm)
2.1.4.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.001 1 0.28 4 0 1000 0 }
2.1.4.10 'length root tip without xylem vessels' = 2 (cm)
2.1.4.11 'longitudinal growth rate multiplier' (cm) minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.1.4.12 'nitrate'

2.1.4.12.1 ' Cmin' = 0.0017 (uMol/ml)
2.1.4.12.2 ' Imax' = 1.27 (uMol/cm2/day)
2.1.4.12.3 ' Km' = 0.0027 (uMol/ml)
2.1.4.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.4.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.4.13 'number of xylem poles' = 4 (noUnit)
2.1.4.14 'phosphorus'

2.1.4.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.4.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.4.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.4.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.4.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.4.15 'potassium'

2.1.4.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.4.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.4.15.3 ' Km' = 0.014 (uMol/ml)
2.1.4.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.4.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.4.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 1 1 }

2.1.4.17 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 1e-06 }
2.1.4.18 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.4.19 'root class ID' = 98 (noUnit)
2.1.4.20 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.4.21 'root hair diameter' = 0.0005 (cm)
2.1.4.22 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.4.23 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.1.4.24 'top boundary' = 1 (noUnit)

2.1.5 'hypocotyl'

2.1.5.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.1.5.2 'bottom boundary' = 1 (noUnit)
2.1.5.3 'bounce of the side' = 1 (noUnit)
2.1.5.4 'branch list'

2.1.5.4.1 'braceroots'

2.1.5.4.1.1 'allometric scaling' = 1 (noUnit)
2.1.5.4.1.2 'branching spatial offset' = 4 (cm)
2.1.5.4.1.3 'branching time offset' = 25 (day)
2.1.5.4.1.4 'number of branches/whorl' = 14 (#)

2.1.5.4.2 'braceroots2'

2.1.5.4.2.1 'allometric scaling' = 1 (noUnit)
2.1.5.4.2.2 'branching delay' = 14 (day)
2.1.5.4.2.3 'branching frequency' = 5 (cm)
2.1.5.4.2.4 'branching spatial offset' = 7 (cm)
2.1.5.4.2.5 'branching time offset' = 36 (day)
2.1.5.4.2.6 'number of branches/whorl' = 20 (#)

2.1.5.4.3 'nodalroots'

2.1.5.4.3.1 'branching spatial offset' = 1.5 (cm)
2.1.5.4.3.2 'branching time offset' = 9 (day)
2.1.5.4.3.3 'number of branches/whorl' = 3 (#)

2.1.5.4.4 'nodalroots2'

2.1.5.4.4.1 'allometric scaling' = 1 (noUnit)
2.1.5.4.4.2 'branching spatial offset' = 1.9 (cm)
2.1.5.4.4.3 'branching time offset' = 16 (day)
2.1.5.4.4.4 'number of branches/whorl' = 4 (#)

2.1.5.4.5 'nodalroots3'

2.1.5.4.5.1 'allometric scaling' = 1 (noUnit)
2.1.5.4.5.2 'branching spatial offset' = 2.1 (cm)
2.1.5.4.5.3 'branching time offset' = 20 (day)
2.1.5.4.5.4 'number of branches/whorl' = 5 (#)

2.1.5.4.6 'nodalroots4'

2.1.5.4.6.1 'allometric scaling' = 1 (noUnit)
2.1.5.4.6.2 'branching spatial offset' = 2.3 (cm)
2.1.5.4.6.3 'branching time offset' = 23 (day)
2.1.5.4.6.4 'number of branches/whorl' = 6 (#)

2.1.5.5 'density' = 0.094 (g/cm3)
2.1.5.6 'diameter' = 0.15 (cm)
2.1.5.7 'gravitropism' = -1 (noUnit)
2.1.5.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=0.5 maximum=1
2.1.5.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1 1 2 2 2 3 2 5 0 1000 0 }
2.1.5.10 'length root tip without xylem vessels' = 2 (cm)
2.1.5.11 'nitrate'

2.1.5.11.1 ' Cmin' = 0 (uMol/ml)
2.1.5.11.2 ' Imax' = 0 (uMol/cm2/day)
2.1.5.11.3 ' Km' = 1 (uMol/ml)
2.1.5.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.5.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.5.12 'number of xylem poles' = 61 (noUnit)
2.1.5.13 'phosphorus'

2.1.5.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.5.13.2 ' Imax' = 0.0555 (uMol/cm2/day)

2.1.5.13.3 ' Km' = 0.00545 (uMol/ml)
2.1.5.13.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.5.13.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.5.14 'potassium'

2.1.5.14.1 ' Cmin' = 0.002 (uMol/ml)
2.1.5.14.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.5.14.3 ' Km' = 0.014 (uMol/ml)
2.1.5.14.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.5.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.5.15 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.1.5.16 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.1.5.17 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.5.18 'root class ID' = 97 (noUnit)
2.1.5.19 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 0 2000 0 }
2.1.5.20 'root hair diameter' = 0.0005 (cm)
2.1.5.21 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.5.22 'soil impedence' = 0.3 (noUnit)
2.1.5.23 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.3 maximum=0.3
2.1.5.24 'top boundary' = 0 (noUnit)

2.1.6 'lateral'

2.1.6.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.1.6.2 'bottom boundary' = 1 (noUnit)
2.1.6.3 'bounce of the side' = 1 (noUnit)
2.1.6.4 'branch list'

2.1.6.4.1 'finelateral'

2.1.6.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.6.4.1.2 'branching frequency' (cm) minimum=0.15 maximum=0.35
2.1.6.4.1.3 'length root tip' = 4 (cm)

2.1.6.5 'branching angle' = 90 (degrees)
2.1.6.6 'density' = 0.094 (g/cm3)
2.1.6.7 'diameter' = 0.04 (cm)
2.1.6.8 'gravitropism.v2' = 0 0 0 (cm)
2.1.6.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 1 0.2 3 0.7 5 1 11 0 1000 0 }
2.1.6.10 'length root tip without xylem vessels' = 2 (cm)
2.1.6.11 'longitudinal growth rate multiplier' (cm) minimum=0.1 maximum=2 mean=0.7 stdev=0.3
2.1.6.12 'nitrate'

2.1.6.12.1 ' Cmin' = 0.0017 (uMol/ml)
2.1.6.12.2 ' Imax' = 1.27 (uMol/cm2/day)
2.1.6.12.3 ' Km' = 0.0027 (uMol/ml)
2.1.6.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.6.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.6.13 'number of xylem poles' = 4 (noUnit)
2.1.6.14 'phosphorus'

2.1.6.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.6.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.6.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.6.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.6.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.6.15 'potassium'

2.1.6.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.6.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.6.15.3 ' Km' = 0.014 (uMol/ml)
2.1.6.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.6.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.6.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 1 1 }
2.1.6.17 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 3e-06 }
2.1.6.18 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.6.19 'root class ID' = 98 (noUnit)
2.1.6.20 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.6.21 'root hair diameter' = 0.0005 (cm)

2.1.6.22 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.6.23 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.1.6.24 'top boundary' = 1 (noUnit)

2.1.7 'lateral of crown roots'

2.1.7.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.1.7.2 'bottom boundary' = 1 (noUnit)
2.1.7.3 'bounce of the side' = 1 (noUnit)
2.1.7.4 'branch list'

2.1.7.4.1 'lateral'

2.1.7.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.7.4.1.2 'branching frequency' (cm) minimum=0.25 maximum=0.35
2.1.7.4.1.3 'length root tip' = 5 (cm)

2.1.7.5 'branching angle' = 90 (degrees)
2.1.7.6 'density' = 0.094 (g/cm3)
2.1.7.7 'diameter' = 0.07 (cm)
2.1.7.8 'gravitropism' = 0 (noUnit)
2.1.7.9 'gravitropism.v2' = 0 0 0 (cm)
2.1.7.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.1 1 0.5 3 1.2 12 1.2 18 0 1000 0 }
2.1.7.11 'length root tip without xylem vessels' = 2 (cm)
2.1.7.12 'longitudinal growth rate multiplier' (cm) minimum=0.1 maximum=1 mean=0.4 stdev=0.3
2.1.7.13 'nitrate'

2.1.7.13.1 ' Cmin' = 0.0017 (uMol/ml)
2.1.7.13.2 ' Imax' = 1.27 (uMol/cm2/day)
2.1.7.13.3 ' Km' = 0.0027 (uMol/ml)
2.1.7.13.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.7.13.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.7.14 'number of xylem poles' = 4 (noUnit)
2.1.7.15 'phosphorus'

2.1.7.15.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.7.15.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.7.15.3 ' Km' = 0.00545 (uMol/ml)
2.1.7.15.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.7.15.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.7.16 'potassium'

2.1.7.16.1 ' Cmin' = 0.002 (uMol/ml)
2.1.7.16.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.7.16.3 ' Km' = 0.014 (uMol/ml)
2.1.7.16.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.7.16.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.7.17 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 1 1 }
2.1.7.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 4e-06 }
2.1.7.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.7.20 'root class ID' = 98 (noUnit)
2.1.7.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.7.22 'root hair diameter' = 0.0005 (cm)
2.1.7.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.7.24 'soil impedence' = 0.05 (noUnit)
2.1.7.25 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.1.7.26 'top boundary' = 1 (noUnit)

2.1.8 'local resource responses'

2.1.8.1 'impact on:gravitropism'

2.1.8.1.1 'aggregation function' = average (noUnit)
2.1.8.1.2 'impact by:nitrate' (noUnit) =f{'localConcentration'} (noUnit) x,y pairs :{ 0 3 100 1 2000 1 }
2.1.8.1.3 'impact by:phosphorus' (noUnit) =f{'localConcentration'} (noUnit) x,y pairs :{ 0 0.3 15 1 1000 1 }
2.1.8.1.4 'impact by:potassium' (noUnit) =f{'localConcentration'} (noUnit) x,y pairs :{ 0 1 1000 1 }

2.1.9 'nodalroots'

2.1.9.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.08 10 0.16 1000 0.16 }
2.1.9.2 'bottom boundary' = 1 (noUnit)
2.1.9.3 'bounce of the side' = 1 (noUnit)
2.1.9.4 'branch list'

2.1.9.4.1 'lateral'

2.1.9.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.9.4.1.2 'branching frequency' (cm) minimum=0.1 maximum=0.3
2.1.9.4.1.3 'length root tip' = 10.93 (cm)

2.1.9.5 'branching angle' = 160 (degrees)
2.1.9.6 'density' = 0.094 (g/cm3)
2.1.9.7 'diameter' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0.085 7 0.094 100 0.085 }
2.1.9.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.9.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0 }
2.1.9.10 'length root tip without xylem vessels' = 2 (cm)
2.1.9.11 'longitudinal growth rate multiplier' (cm) minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.9.12 'nitrate'

2.1.9.12.1 ' Cmin' = 0.001 (uMol/ml)
2.1.9.12.2 ' Imax' (uMol/cm2/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.21 2 2.1 40 2.1 }
2.1.9.12.3 ' Km' (uMol/ml) =f{'time since creation'} (day) x,y pairs :{ 0 0.0157 2 0.0522 40 0.0522 }
2.1.9.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.9.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.9.13 'number of xylem poles' = 10 (noUnit)
2.1.9.14 'phosphorus'

2.1.9.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.9.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.9.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.9.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.9.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.9.15 'potassium'

2.1.9.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.9.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.9.15.3 ' Km' = 0.014 (uMol/ml)
2.1.9.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.9.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.9.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 1 1 }
2.1.9.17 'regular topology' = 3 (noUnit)
2.1.9.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 5e-06 }
2.1.9.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.9.20 'root class ID' = 101 (noUnit)
2.1.9.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.9.22 'root hair diameter' = 0.0005 (cm)
2.1.9.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.9.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.1.9.25 'top boundary' = 1 (noUnit)
2.1.9.26 'topology offset' = 0 (noUnit)

2.1.10 'nodalroots2'

2.1.10.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.07 10 0.145 1000 0.145 }
2.1.10.2 'bottom boundary' = 1 (noUnit)
2.1.10.3 'bounce of the side' = 1 (noUnit)
2.1.10.4 'branch list'

2.1.10.4.1 'lateral'

2.1.10.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.10.4.1.2 'branching frequency' (cm) minimum=0.1 maximum=0.3
2.1.10.4.1.3 'length root tip' = 10.93 (cm)

2.1.10.5 'branching angle' = 150 (degrees)
2.1.10.6 'density' = 0.094 (g/cm3)
2.1.10.7 'diameter' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0.133 7 0.128 100 0.128 }
2.1.10.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.10.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0 }
2.1.10.10 'length root tip without xylem vessels' = 2 (cm)
2.1.10.11 'longitudinal growth rate multiplier' (cm) minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.10.12 'nitrate'

2.1.10.12.1 ' Cmin' = 0.001 (uMol/ml)

2.1.10.12.2 ' Imax' (uMol/cm2/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.21 2 2.1 40 2.1 }
2.1.10.12.3 ' Km' (uMol/ml) =f{'time since creation'} (day) x,y pairs :{ 0 0.0157 2 0.0522 40 0.0522 }
2.1.10.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.10.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.10.13 'number of xylem poles' = 18 (noUnit)
2.1.10.14 'phosphorus'

2.1.10.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.10.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.10.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.10.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.10.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.10.15 'potassium'

2.1.10.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.10.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.10.15.3 ' Km' = 0.014 (uMol/ml)
2.1.10.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.10.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.10.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 1 1 }
2.1.10.17 'regular topology' = 0 (noUnit)
2.1.10.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 5e-06 }
2.1.10.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.10.20 'root class ID' = 101 (noUnit)
2.1.10.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.10.22 'root hair diameter' = 0.0005 (cm)
2.1.10.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.10.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.1.10.25 'top boundary' = 1 (noUnit)
2.1.10.26 'topology offset' = 0 (noUnit)

2.1.11 'nodalroots3'

2.1.11.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.09 10 0.19 1000 0.19 }
2.1.11.2 'bottom boundary' = 1 (noUnit)
2.1.11.3 'bounce of the side' = 1 (noUnit)
2.1.11.4 'branch list'

2.1.11.4.1 'lateral'

2.1.11.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.11.4.1.2 'branching frequency' (cm) minimum=0.1 maximum=0.3
2.1.11.4.1.3 'length root tip' = 10.93 (cm)

2.1.11.5 'branching angle' = 140 (degrees)
2.1.11.6 'density' = 0.094 (g/cm3)
2.1.11.7 'diameter' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0.155 7 0.182 100 0.155 }
2.1.11.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.11.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0 }
2.1.11.10 'length root tip without xylem vessels' = 2 (cm)
2.1.11.11 'longitudinal growth rate multiplier' (cm) minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.11.12 'nitrate'

2.1.11.12.1 ' Cmin' = 0.001 (uMol/ml)
2.1.11.12.2 ' Imax' (uMol/cm2/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.21 2 2.1 40 2.1 }
2.1.11.12.3 ' Km' (uMol/ml) =f{'time since creation'} (day) x,y pairs :{ 0 0.0157 2 0.0522 40 0.0522 }
2.1.11.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.11.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.11.13 'number of xylem poles' = 24 (noUnit)
2.1.11.14 'phosphorus'

2.1.11.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.11.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.11.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.11.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.11.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.11.15 'potassium'

2.1.11.15.1 ' Cmin' = 0.002 (uMol/ml)

2.1.11.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.11.15.3 ' Km' = 0.014 (uMol/ml)
2.1.11.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.11.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.11.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 1 1 }
2.1.11.17 'regular topology' = 0 (noUnit)
2.1.11.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 5e-06 }
2.1.11.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.11.20 'root class ID' = 101 (noUnit)
2.1.11.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.11.22 'root hair diameter' = 0.0005 (cm)
2.1.11.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.11.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.1.11.25 'top boundary' = 1 (noUnit)
2.1.11.26 'topology offset' = 0 (noUnit)

2.1.12 'nodalroots4'

2.1.12.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.09 10 0.19 1000 0.19 }
2.1.12.2 'bottom boundary' = 1 (noUnit)
2.1.12.3 'bounce of the side' = 1 (noUnit)
2.1.12.4 'branch list'

2.1.12.4.1 'lateral'

2.1.12.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.12.4.1.2 'branching frequency' (cm) minimum=0.1 maximum=0.3
2.1.12.4.1.3 'length root tip' = 10.93 (cm)

2.1.12.5 'branching angle' = 130 (degrees)
2.1.12.6 'density' = 0.094 (g/cm3)
2.1.12.7 'diameter' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0.155 7 0.182 100 0.155 }
2.1.12.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.12.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0 }
2.1.12.10 'length root tip without xylem vessels' = 2 (cm)
2.1.12.11 'longitudinal growth rate multiplier' (cm) minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.12.12 'nitrate'

2.1.12.12.1 ' Cmin' = 0.001 (uMol/ml)
2.1.12.12.2 ' Imax' (uMol/cm2/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.21 2 2.1 40 2.1 }
2.1.12.12.3 ' Km' (uMol/ml) =f{'time since creation'} (day) x,y pairs :{ 0 0.0157 2 0.0522 40 0.0522 }
2.1.12.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.12.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.12.13 'number of xylem poles' = 32 (noUnit)
2.1.12.14 'phosphorus'

2.1.12.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.12.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.12.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.12.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.12.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.12.15 'potassium'

2.1.12.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.12.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.12.15.3 ' Km' = 0.014 (uMol/ml)
2.1.12.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.12.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.12.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 1 1 }
2.1.12.17 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 5e-06 }
2.1.12.18 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.12.19 'root class ID' = 101 (noUnit)
2.1.12.20 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.12.21 'root hair diameter' = 0.0005 (cm)
2.1.12.22 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.12.23 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.02 maximum=0.02

2.1.12.24 'top boundary' = 1 (noUnit)

2.1.13 'primary root'

2.1.13.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.175 1000 0.175 }
2.1.13.2 'bottom boundary' = 1 (noUnit)
2.1.13.3 'bounce of the side' = 1 (noUnit)
2.1.13.4 'branch list'

2.1.13.4.1 'lateral'

2.1.13.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.13.4.1.2 'branching frequency' (cm) minimum=0.25 maximum=0.45
2.1.13.4.1.3 'length root tip' = 10.93 (cm)

2.1.13.4.2 'seminal'

2.1.13.4.2.1 'allow branches to form above ground' = 0 (noUnit)
2.1.13.4.2.2 'branching frequency' = 1 (cm)
2.1.13.4.2.3 'branching time offset' = 1 (day)
2.1.13.4.2.4 'max number of branches' = 5 (#)
2.1.13.4.2.5 'number of branches/whorl' = 5 (#)

2.1.13.5 'branching angle' = 0 (degrees)
2.1.13.6 'density' = 0.094 (g/cm3)
2.1.13.7 'diameter' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0.103 7 0.086 100 0.086 }
2.1.13.8 'gravitropism' = 0.01 (noUnit)
2.1.13.9 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.015 maximum=-0.005
2.1.13.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 4.5 28 4.5 38 0 1000 0 }
2.1.13.11 'length root tip without xylem vessels' = 2 (cm)
2.1.13.12 'nitrate'

2.1.13.12.1 ' Cmin' = 0.001 (uMol/ml)
2.1.13.12.2 ' Imax' (uMol/cm2/day) =f{'time since creation'} (day) x,y pairs :{ 0 2.3 2 1.92 40 1.92 }
2.1.13.12.3 ' Km' (uMol/ml) =f{'time since creation'} (day) x,y pairs :{ 0 0.0105 2 0.0161 40 0.0161 }
2.1.13.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.13.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.13.13 'number of xylem poles' = 8 (noUnit)
2.1.13.14 'phosphorus'

2.1.13.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.13.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.13.14.3 ' Km' = 0.00545 (uMol/ml)
2.1.13.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.13.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.13.15 'potassium'

2.1.13.15.1 ' Cmin' = 0.002 (uMol/ml)
2.1.13.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.13.15.3 ' Km' = 0.014 (uMol/ml)
2.1.13.15.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.13.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.13.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.1.13.17 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 5e-06 }
2.1.13.18 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.13.19 'root class ID' = 100 (noUnit)
2.1.13.20 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.13.21 'root hair diameter' = 0.0005 (cm)
2.1.13.22 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.13.23 'soil impedence' = 0.05 (noUnit)
2.1.13.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.1.13.25 'top boundary' = 1 (noUnit)

2.1.14 'resources'

2.1.14.1 ' cto dry weight ratio' = 0.45 (100%)
2.1.14.2 'carbon allocation2 leafs factor' (100%) =f{'time'} (day) x,y pairs :{ 0 1 10 0.7 20 0.45 33 0.42 40 0.4 60 0.4 }
2.1.14.3 'carbon allocation2 roots factor' (100%) =f{'time'} (day) x,y pairs :{ 0 1 1 1 6 0.4 20 0.2 40 0.17 80 0.17 }
2.1.14.4 'carbon cost of nitrate uptake' = 1.392e-05 (g/uMol)

2.1.14.5 'max carbon allocation2 shoot' = 0.82 (100%)
2.1.14.6 'nitrate'

2.1.14.6.1 'initial nutrient uptake' = 285 (uMol)

2.1.14.7 'phosphorus'

2.1.14.7.1 'initial nutrient uptake' = 20 (uMol)

2.1.14.8 'potassium'

2.1.14.8.1 'initial nutrient uptake' = 27 (uMol)

2.1.14.9 'reserve allocation rate' (%/day) =f{'time'} (day) x,y pairs :{ 0 0.01 1 0.02 2 0.04 3 0.04 10 0.2 11 0.2 1000 0.2 }
2.1.14.10 'seed size' = 0.15 (g)

2.1.15 'seminal'

2.1.15.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.158 1000 0.158 }
2.1.15.2 'bottom boundary' = 1 (noUnit)
2.1.15.3 'bounce of the side' = 1 (noUnit)
2.1.15.4 'branch list'

2.1.15.4.1 'lateral'

2.1.15.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.1.15.4.1.2 'branching frequency' (cm) minimum=0.05 maximum=0.25
2.1.15.4.1.3 'length root tip' = 10.93 (cm)

2.1.15.5 'branching angle' = 90 (degrees)
2.1.15.6 'density' = 0.094 (g/cm3)
2.1.15.7 'diameter' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0.083 7 0.072 100 0.072 }
2.1.15.8 'gravitropism' = 0.004 (noUnit)
2.1.15.9 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.035 maximum=-0.025
2.1.15.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.01 1 0.5 2 4.5 28 4.5 38 0 100 0 }
2.1.15.11 'length root tip without xylem vessels' = 2 (cm)
2.1.15.12 'longitudinal growth rate multiplier' (cm) minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.15.13 'nitrate'

2.1.15.13.1 ' Cmin' = 0.001 (uMol/ml)
2.1.15.13.2 ' Imax' (uMol/cm2/day) =f{'time since creation'} (day) x,y pairs :{ 0 2.3 2 1.92 40 1.92 }
2.1.15.13.3 ' Km' (uMol/ml) =f{'time since creation'} (day) x,y pairs :{ 0 0.0105 2 0.0161 40 0.0161 }
2.1.15.13.4 'minimal nutrient concentration' = 600 (uMol/g)
2.1.15.13.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.1.15.14 'number of xylem poles' = 6 (noUnit)
2.1.15.15 'phosphorus'

2.1.15.15.1 ' Cmin' = 0.0002 (uMol/ml)
2.1.15.15.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.1.15.15.3 ' Km' = 0.00545 (uMol/ml)
2.1.15.15.4 'minimal nutrient concentration' = 30 (uMol/g)
2.1.15.15.5 'optimal nutrient concentration' = 60 (uMol/g)

2.1.15.16 'potassium'

2.1.15.16.1 ' Cmin' = 0.002 (uMol/ml)
2.1.15.16.2 ' Imax' = 0.467 (uMol/cm2/day)
2.1.15.16.3 ' Km' = 0.014 (uMol/ml)
2.1.15.16.4 'minimal nutrient concentration' = 117 (uMol/g)
2.1.15.16.5 'optimal nutrient concentration' = 234 (uMol/g)

2.1.15.17 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.1.15.18 'regular topology' = 1 (noUnit)
2.1.15.19 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 5e-06 100 5e-06 }
2.1.15.20 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.1.15.21 'root class ID' = 99 (noUnit)
2.1.15.22 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 1 2000 2 2000 10 2000 30 0 2000 0 }
2.1.15.23 'root hair diameter' = 0.0005 (cm)
2.1.15.24 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.028 2000 0.028 }
2.1.15.25 'soil impedence' = 0.02 (noUnit)
2.1.15.26 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.1.15.27 'top boundary' = 1 (noUnit)

2.1.16 'shoot'

2.1.16.1 'aerenchyma photosynthesis mitigation' = 0.5 (100%)
2.1.16.2 'area per plant' = 1600 (cm2)
2.1.16.3 'extinction coefficient' = 0.85 (noUnit)
2.1.16.4 'leaf area expantion rate' (cm2/day) =f{'time'} (day) x,y pairs :{ 0 0 2 0 2.38 2.32 2.77 3.24 3.15 3.93 3.54 4.41 3.92 4.72 4.3 4.87 4.69 4.89 5.07 4.81 5.45 4.64 5.84 4.41 6.22 4.14 6.61 3.84 6.99 3.55 7.37 3.27 7.76 3.02 8.14 2.83 8.53 2.71 8.91 2.66 9.29 2.71 9.68 2.88 10.06 3.16 10.44 3.58 10.83 4.15 11.21 4.87 11.6 5.76 11.98 6.82 12.36 8.07 12.75 9.5 13.13 11.13 13.52 12.96 13.9 14.99 14.28 17.23 14.67 19.68 15.05 22.35 15.43 25.22 15.82 28.32 16.2 31.62 16.59 35.14 16.97 38.87 17.35 42.81 17.74 46.95 18.12 51.29 18.51 55.83 18.89 60.55 19.27 65.45 19.66 70.53 20.04 75.76 20.42 81.16 20.81 86.69 21.19 92.36 21.58 98.15 21.96 104.05 22.34 110.04 22.73 116.11 23.11 122.24 23.49 128.42 23.88 134.63 24.26 140.86 24.65 147.08 25.03 153.28 25.41 159.42 25.8 165.51 26.18 171.5 26.57 177.39 26.95 183.14 27.33 188.73 27.72 194.13 28.1 199.33 28.48 204.29 28.87 208.98 29.25 213.38 29.64 217.45 30.02 221.18 30.4 224.52 30.79 227.44 31.17 229.92 31.56 231.91 31.94 233.39 33.09 234.36 50 234.36 80 0 }

2.1.16.4.1 'multiplier' = 1.2 (noUnit)

2.1.16.5 'light use efficiency' = 3.8e-07 (g/uMol)
2.1.16.6 'nitrate'

2.1.16.6.1 'leaf minimal nutrient concentration' (uMol/g) =f{'time'} (day) x,y pairs :{ 0 1200 80 800 }
2.1.16.6.2 'leaf optimal nutrient concentration' (uMol/g) =f{'time'} (day) x,y pairs :{ 0 2500 80 1500 }
2.1.16.6.3 'stem minimal nutrient concentration' = 400 (uMol/g)
2.1.16.6.4 'stem optimal nutrient concentration' = 800 (uMol/g)

2.1.16.7 'phosphorus'

2.1.16.7.1 'leaf minimal nutrient concentration' = 35 (uMol/g)
2.1.16.7.2 'leaf optimal nutrient concentration' = 70 (uMol/g)
2.1.16.7.3 'stem minimal nutrient concentration' = 15 (uMol/g)
2.1.16.7.4 'stem optimal nutrient concentration' = 30 (uMol/g)

2.1.16.8 'potassium'

2.1.16.8.1 'leaf minimal nutrient concentration' = 273 (uMol/g)
2.1.16.8.2 'leaf optimal nutrient concentration' = 508 (uMol/g)
2.1.16.8.3 'stem minimal nutrient concentration' = 117 (uMol/g)
2.1.16.8.4 'stem optimal nutrient concentration' = 250 (uMol/g)

2.1.16.9 'relative potential transpiration' = 100 (cm3/g)
2.1.16.10 'relative respiration rate leafs' = 0.04 (g/g/day)
2.1.16.11 'relative respiration rate stems' = 0.02 (g/g/day)
2.1.16.12 'specific leaf area' (g/cm2) =f{'time'} (day) x,y pairs :{ 0 0.0015 24 0.0026 50 0.0032 100 0.0032 }

2.1.17 'stress impact factors'

2.1.17.1 'impact on:leaf area expantion rate'

2.1.17.1.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 0.3 0.1 1 1 }
2.1.17.1.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.1.17.1.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 0 0.2 0.5 1 1 }

2.1.17.2 'impact on:photosynthesis'

2.1.17.2.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 0.4 0.5 1 1 }
2.1.17.2.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0.5 0.5 1 1 1 }
2.1.17.2.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }

2.1.17.3 'impact on:root segment carbon cost of exudates'

2.1.17.3.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.1.17.3.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.1.17.3.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }

2.1.17.4 'impact on:root segment respiration'

2.1.17.4.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.1.17.4.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.1.17.4.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }

2.1.17.5 'impact on:root segment secondary growth'

2.1.17.5.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.1.17.5.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.1.17.5.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }

2.2 ' bean- carioca- sim root4'

2.2.1 'basal whorl1'

2.2.1.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }

2.2.1.2 'bottom boundary' = 1 (noUnit)
2.2.1.3 'bounce of the side' = 1 (noUnit)
2.2.1.4 'branch list'

2.2.1.4.1 'lateral basal roots'

2.2.1.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.2.1.4.1.2 'branching frequency' = 0.15 (cm)
2.2.1.4.1.3 'length root tip' = 8 (cm)

2.2.1.5 'branching angle' = 90 (degrees)
2.2.1.6 'density' = 0.094 (g/cm3)
2.2.1.7 'diameter' = 0.068 (cm)
2.2.1.8 'gravitropism' = 0.002 (noUnit)
2.2.1.9 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.08 maximum=-0.04
2.2.1.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.1 3 4 10 4 15 3 25 2.352 35 2.352 40 0 1000 0 }
2.2.1.11 'nitrate'

2.2.1.11.1 ' Cmin' = 0.001 (uMol/ml)
2.2.1.11.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.1.11.3 ' Km' = 0.0161 (uMol/ml)
2.2.1.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.1.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.1.12 'number of xylem poles' = 4 (noUnit)
2.2.1.13 'phosphorus'

2.2.1.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.1.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.1.13.3 ' Km' = 0.00545 (uMol/ml)
2.2.1.13.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.1.13.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.1.14 'potassium'

2.2.1.14.1 ' Cmin' = 0.002 (uMol/ml)
2.2.1.14.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.1.14.3 ' Km' = 0.039 (uMol/ml)
2.2.1.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.1.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.1.15 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.1.16 'regular topology' = 0 (noUnit)
2.2.1.17 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.1.18 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.1.19 'root class ID' = 99 (noUnit)
2.2.1.20 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 10 2000 30 2000 100 2000 }
2.2.1.21 'root hair diameter' = 0.0005 (cm)
2.2.1.22 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.1.23 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 2 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.2.1.24 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 0.7 20 0.7 40 0.4 100 0.4 }
2.2.1.25 'soil impedence' = 0.008 (noUnit)
2.2.1.26 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.2.1.27 'top boundary' = 1 (noUnit)

2.2.2 'basal whorl2'

2.2.2.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.2.2 'bottom boundary' = 1 (noUnit)
2.2.2.3 'bounce of the side' = 1 (noUnit)
2.2.2.4 'branch list'

2.2.2.4.1 'lateral basal roots'

2.2.2.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.2.2.4.1.2 'branching frequency' = 0.15 (cm)
2.2.2.4.1.3 'length root tip' = 10 (cm)

2.2.2.5 'branching angle' = 90 (degrees)
2.2.2.6 'density' = 0.094 (g/cm3)

2.2.2.7 'diameter' = 0.068 (cm)
2.2.2.8 'gravitropism' = 0.001 (noUnit)
2.2.2.9 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.04 maximum=-0.02
2.2.2.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.1 3 4 10 4 15 3 25 2.352 35 2.352 40 0 1000 0 }
2.2.2.11 'nitrate'

2.2.2.11.1 ' Cmin' = 0.001 (uMol/ml)
2.2.2.11.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.2.11.3 ' Km' = 0.0161 (uMol/ml)
2.2.2.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.2.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.2.12 'number of xylem poles' = 4 (noUnit)
2.2.2.13 'phosphorus'

2.2.2.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.2.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.2.13.3 ' Km' = 0.00545 (uMol/ml)
2.2.2.13.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.2.13.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.2.14 'potassium'

2.2.2.14.1 ' Cmin' = 0.002 (uMol/ml)
2.2.2.14.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.2.14.3 ' Km' = 0.039 (uMol/ml)
2.2.2.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.2.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.2.15 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.2.16 'regular topology' = 0 (noUnit)
2.2.2.17 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.2.18 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.2.19 'root class ID' = 99 (noUnit)
2.2.2.20 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 10 2000 30 2000 100 2000 }
2.2.2.21 'root hair diameter' = 0.0005 (cm)
2.2.2.22 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.2.23 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 2 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.2.2.24 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 0.7 20 0.7 40 0.4 100 0.4 }
2.2.2.25 'soil impedence' = 0.008 (noUnit)
2.2.2.26 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.2.2.27 'top boundary' = 1 (noUnit)

2.2.3 'basal whorl3'

2.2.3.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.3.2 'bottom boundary' = 1 (noUnit)
2.2.3.3 'bounce of the side' = 1 (noUnit)
2.2.3.4 'branch list'

2.2.3.4.1 'lateral basal roots'

2.2.3.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.2.3.4.1.2 'branching frequency' = 0.15 (cm)
2.2.3.4.1.3 'length root tip' = 10 (cm)

2.2.3.5 'branching angle' = 90 (degrees)
2.2.3.6 'density' = 0.094 (g/cm3)
2.2.3.7 'diameter' = 0.068 (cm)
2.2.3.8 'gravitropism' = 0.0005 (noUnit)
2.2.3.9 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.02 maximum=-0.01
2.2.3.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.1 2 4 10 4 15 3 25 2.352 35 2.352 40 0 1000 0 }
2.2.3.11 'nitrate'

2.2.3.11.1 ' Cmin' = 0.001 (uMol/ml)
2.2.3.11.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.3.11.3 ' Km' = 0.0161 (uMol/ml)
2.2.3.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.3.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.3.12 'number of xylem poles' = 4 (noUnit)
2.2.3.13 'phosphorus'

2.2.3.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.3.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.3.13.3 ' Km' = 0.00545 (uMol/ml)
2.2.3.13.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.3.13.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.3.14 'potassium'

2.2.3.14.1 ' Cmin' = 0.002 (uMol/ml)
2.2.3.14.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.3.14.3 ' Km' = 0.039 (uMol/ml)
2.2.3.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.3.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.3.15 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.3.16 'regular topology' = 0 (noUnit)
2.2.3.17 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.3.18 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.3.19 'root class ID' = 99 (noUnit)
2.2.3.20 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 10 2000 30 2000 100 2000 }
2.2.3.21 'root hair diameter' = 0.0005 (cm)
2.2.3.22 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.3.23 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.2.3.24 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 0.7 20 0.7 40 0.4 100 0.4 }
2.2.3.25 'soil impedence' = 0.008 (noUnit)
2.2.3.26 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.2.3.27 'top boundary' = 1 (noUnit)

2.2.4 'finelateral'

2.2.4.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.4.2 'bottom boundary' = 1 (noUnit)
2.2.4.3 'bounce of the side' = 1 (noUnit)
2.2.4.4 'branch list'
2.2.4.5 'branching angle' = 75 (degrees)
2.2.4.6 'density' = 0.094 (g/cm3)
2.2.4.7 'diameter' = 0.01 (cm)
2.2.4.8 'gravitropism' = 0 (noUnit)
2.2.4.9 'gravitropism.v2' = 0 0 0 (cm)
2.2.4.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.2 3 0.2 5 0 100 0 }
2.2.4.11 'longitudinal growth rate multiplier' (cm) minimum=0.3 maximum=1 mean=0.6 stdev=0.1
2.2.4.12 'nitrate'

2.2.4.12.1 ' Cmin' = 0.001 (uMol/ml)
2.2.4.12.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.4.12.3 ' Km' = 0.0161 (uMol/ml)
2.2.4.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.4.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.4.13 'number of xylem poles' = 4 (noUnit)
2.2.4.14 'phosphorus'

2.2.4.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.4.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.4.14.3 ' Km' = 0.00545 (uMol/ml)
2.2.4.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.4.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.4.15 'potassium'

2.2.4.15.1 ' Cmin' = 0.002 (uMol/ml)
2.2.4.15.2 ' Imax' = 0.467 (uMol/cm2/day)

2.2.4.15.3 ' Km' = 0.039 (uMol/ml)
2.2.4.15.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.4.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.4.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.4.17 'regular topology' = 0 (noUnit)
2.2.4.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.4.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.4.20 'root class ID' = 97 (noUnit)
2.2.4.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.2.4.22 'root hair diameter' = 0.0005 (cm)
2.2.4.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.4.24 'soil impedence' = 0.5 (noUnit)
2.2.4.25 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.2.4.26 'top boundary' = 1 (noUnit)
2.2.4.27 'topology offset' = 0 (noUnit)

2.2.5 'finelateral fast growing'

2.2.5.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.5.2 'bottom boundary' = 1 (noUnit)
2.2.5.3 'bounce of the side' = 1 (noUnit)
2.2.5.4 'branch list'
2.2.5.5 'branching angle' = 75 (degrees)
2.2.5.6 'density' = 0.094 (g/cm3)
2.2.5.7 'diameter' = 0.015 (cm)
2.2.5.8 'gravitropism' = 0 (noUnit)
2.2.5.9 'gravitropism.v2' = 0 0 0 (cm)
2.2.5.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.5 1 0.8 2 1 3 1 4 0 100 0 }
2.2.5.11 'longitudinal growth rate multiplier' (cm) minimum=0.3 maximum=1 mean=0.6 stdev=0.1
2.2.5.12 'nitrate'

2.2.5.12.1 ' Cmin' = 0.001 (uMol/ml)
2.2.5.12.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.5.12.3 ' Km' = 0.0161 (uMol/ml)
2.2.5.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.5.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.5.13 'number of xylem poles' = 4 (noUnit)
2.2.5.14 'phosphorus'

2.2.5.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.5.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.5.14.3 ' Km' = 0.00545 (uMol/ml)
2.2.5.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.5.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.5.15 'potassium'

2.2.5.15.1 ' Cmin' = 0.002 (uMol/ml)
2.2.5.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.5.15.3 ' Km' = 0.039 (uMol/ml)
2.2.5.15.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.5.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.5.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.5.17 'regular topology' = 0 (noUnit)
2.2.5.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.5.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.5.20 'root class ID' = 97 (noUnit)
2.2.5.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.2.5.22 'root hair diameter' = 0.0005 (cm)
2.2.5.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.5.24 'soil impedence' = 0.5 (noUnit)
2.2.5.25 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.2.5.26 'top boundary' = 1 (noUnit)
2.2.5.27 'topology offset' = 0 (noUnit)

2.2.6 'hypocotyl'

2.2.6.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.2.6.2 'bottom boundary' = 1 (noUnit)
2.2.6.3 'bounce of the side' = 1 (noUnit)
2.2.6.4 'branch list'

2.2.6.4.1 'basal whorl1'

2.2.6.4.1.1 'branching frequency' = 0.01 (cm)
2.2.6.4.1.2 'branching spatial offset' = 0.01 (cm)
2.2.6.4.1.3 'branching time offset' = 4.167 (day)
2.2.6.4.1.4 'max number of branches' = 4 (#)
2.2.6.4.1.5 'number of branches/whorl' = 4 (#)

2.2.6.4.2 'basal whorl2'

2.2.6.4.2.1 'branching frequency' = 0.5 (cm)
2.2.6.4.2.2 'branching spatial offset' = 0.3 (cm)
2.2.6.4.2.3 'branching time offset' = 6.25 (day)
2.2.6.4.2.4 'max number of branches' = 4 (#)
2.2.6.4.2.5 'number of branches/whorl' = 4 (#)

2.2.6.4.3 'hypocotyl born roots'

2.2.6.4.3.1 'allow branches to form above ground' = 0 (noUnit)
2.2.6.4.3.2 'branching delay' = 0 (day)
2.2.6.4.3.3 'branching frequency' = 0.4 (cm)
2.2.6.4.3.4 'branching spatial offset' = 0.4 (cm)
2.2.6.4.3.5 'branching time offset' = 10 (day)
2.2.6.4.3.6 'max number of branches' = 10 (#)

2.2.6.5 'density' = 0.094 (g/cm3)
2.2.6.6 'diameter' = 0.4 (cm)
2.2.6.7 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=0.5 maximum=0.6
2.2.6.8 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1 1 3 2 3 3 1 3.3 0.5 4 0.2 5 0 1000 0 }
2.2.6.9 'nitrate'

2.2.6.9.1 ' Cmin' = 0.001 (uMol/ml)
2.2.6.9.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.6.9.3 ' Km' = 0.0161 (uMol/ml)
2.2.6.9.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.6.9.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.6.10 'number of xylem poles' = 4 (noUnit)
2.2.6.11 'phosphorus'

2.2.6.11.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.6.11.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.6.11.3 ' Km' = 0.00545 (uMol/ml)
2.2.6.11.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.6.11.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.6.12 'potassium'

2.2.6.12.1 ' Cmin' = 0.002 (uMol/ml)
2.2.6.12.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.6.12.3 ' Km' = 0.039 (uMol/ml)
2.2.6.12.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.6.12.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.6.13 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.6.14 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.2.6.15 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.6.16 'root class ID' = 96 (noUnit)
2.2.6.17 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.2.6.18 'root hair diameter' = 0.0005 (cm)
2.2.6.19 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.6.20 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.2.6.21 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 7 2 7 10 7 1000 7}
2.2.6.22 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.01 maximum=0.01
2.2.6.23 'top boundary' = 0 (noUnit)

2.2.7 'hypocotyl born roots'

2.2.7.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000

0.268 }
2.2.7.2 'bottom boundary' = 1 (noUnit)
2.2.7.3 'bounce of the side' = 1 (noUnit)
2.2.7.4 'branch list'

2.2.7.4.1 'lateral hypocotyl born roots'

2.2.7.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.2.7.4.1.2 'branching frequency' = 0.4 (cm)
2.2.7.4.1.3 'length root tip' = 10 (cm)

2.2.7.5 'branching angle' = 85 (degrees)
2.2.7.6 'density' = 0.094 (g/cm3)
2.2.7.7 'diameter' = 0.064 (cm)
2.2.7.8 'gravitropism' = 0 (noUnit)
2.2.7.9 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.002 maximum=0
2.2.7.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1 25 0.8 35 0 60 0 }
2.2.7.11 'longitudinal growth rate multiplier' (cm) minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.2.7.12 'nitrate'

2.2.7.12.1 ' Cmin' = 0.001 (uMol/ml)
2.2.7.12.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.7.12.3 ' Km' = 0.0161 (uMol/ml)
2.2.7.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.7.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.7.13 'number of xylem poles' = 4 (noUnit)
2.2.7.14 'phosphorus'

2.2.7.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.7.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.7.14.3 ' Km' = 0.00545 (uMol/ml)
2.2.7.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.7.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.7.15 'potassium'

2.2.7.15.1 ' Cmin' = 0.002 (uMol/ml)
2.2.7.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.7.15.3 ' Km' = 0.039 (uMol/ml)
2.2.7.15.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.7.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.7.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.7.17 'regular topology' = 0 (noUnit)
2.2.7.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.7.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.7.20 'root class ID' = 98 (noUnit)
2.2.7.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 10 3000 30 3000 100 3000 }
2.2.7.22 'root hair diameter' = 0.0005 (cm)
2.2.7.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.7.24 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.2.7.25 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 0.6 50 0.2 100 0.2 }
2.2.7.26 'soil impedence' = 0.003 (noUnit)
2.2.7.27 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.2.7.28 'top boundary' = 1 (noUnit)

2.2.8 'lateral basal roots'

2.2.8.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.8.2 'bottom boundary' = 1 (noUnit)
2.2.8.3 'bounce of the side' = 1 (noUnit)
2.2.8.4 'branch list'

2.2.8.4.1 'finelateral'

2.2.8.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.2.8.4.1.2 'branching frequency' = 0.5 (cm)
2.2.8.4.1.3 'length root tip' = 4 (cm)

2.2.8.5 'branching angle' = 75 (degrees)

2.2.8.6 'density' = 0.094 (g/cm3)
2.2.8.7 'diameter' = 0.03 (cm)
2.2.8.8 'gravitropism' = 0 (noUnit)
2.2.8.9 'gravitropism.v2' = 0 0 0 (cm)
2.2.8.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.768 2 0.768 4 0.768 6 0.2 10 0 1000 0 }
2.2.8.11 'longitudinal growth rate multiplier' (cm) minimum=0.6 maximum=1 mean=0.8 stdev=0.1
2.2.8.12 'nitrate'

2.2.8.12.1 ' Cmin' = 0.001 (uMol/ml)
2.2.8.12.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.8.12.3 ' Km' = 0.0161 (uMol/ml)
2.2.8.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.8.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.8.13 'number of xylem poles' = 4 (noUnit)
2.2.8.14 'phosphorus'

2.2.8.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.8.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.8.14.3 ' Km' = 0.00545 (uMol/ml)
2.2.8.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.8.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.8.15 'potassium'

2.2.8.15.1 ' Cmin' = 0.002 (uMol/ml)
2.2.8.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.8.15.3 ' Km' = 0.039 (uMol/ml)
2.2.8.15.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.8.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.8.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.8.17 'regular topology' = 0 (noUnit)
2.2.8.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.8.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.8.20 'root class ID' = 97 (noUnit)
2.2.8.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.2.8.22 'root hair diameter' = 0.0005 (cm)
2.2.8.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.8.24 'soil impedence' = 0.02 (noUnit)
2.2.8.25 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.2.8.26 'top boundary' = 1 (noUnit)
2.2.8.27 'topology offset' = 0 (noUnit)

2.2.9 'lateral hypocotyl born roots'

2.2.9.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.9.2 'bottom boundary' = 1 (noUnit)
2.2.9.3 'bounce of the side' = 1 (noUnit)
2.2.9.4 'branch list'
2.2.9.5 'branching angle' = 75 (degrees)
2.2.9.6 'density' = 0.094 (g/cm3)
2.2.9.7 'diameter' = 0.03 (cm)
2.2.9.8 'gravitropism' = 0 (noUnit)
2.2.9.9 'gravitropism.v2' = 0 0 0 (cm)
2.2.9.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.768 2 0.768 4 0.768 6 0.2 10 0 1000 0 }
2.2.9.11 'longitudinal growth rate multiplier' (cm) minimum=0.6 maximum=1 mean=0.8 stdev=0.1
2.2.9.12 'nitrate'

2.2.9.12.1 ' Cmin' = 0.001 (uMol/ml)
2.2.9.12.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.9.12.3 ' Km' = 0.0161 (uMol/ml)
2.2.9.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.9.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.9.13 'number of xylem poles' = 4 (noUnit)
2.2.9.14 'phosphorus'

2.2.9.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.9.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.9.14.3 ' Km' = 0.00545 (uMol/ml)
2.2.9.14.4 'minimal nutrient concentration' = 30 (uMol/g)

2.2.9.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.9.15 'potassium'

2.2.9.15.1 ' Cmin' = 0.002 (uMol/ml)
2.2.9.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.9.15.3 ' Km' = 0.039 (uMol/ml)
2.2.9.15.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.9.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.9.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.9.17 'regular topology' = 0 (noUnit)
2.2.9.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.9.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.9.20 'root class ID' = 97 (noUnit)
2.2.9.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.2.9.22 'root hair diameter' = 0.0005 (cm)
2.2.9.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.9.24 'soil impedence' = 0.015 (noUnit)
2.2.9.25 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.2.9.26 'top boundary' = 1 (noUnit)
2.2.9.27 'topology offset' = 0 (noUnit)

2.2.10 'lateral primary root'

2.2.10.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.10.2 'bottom boundary' = 1 (noUnit)
2.2.10.3 'bounce of the side' = 1 (noUnit)
2.2.10.4 'branch list'

2.2.10.4.1 'finelateral'

2.2.10.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.2.10.4.1.2 'branching frequency' = 0.5 (cm)
2.2.10.4.1.3 'length root tip' = 4 (cm)

2.2.10.5 'branching angle' = 75 (degrees)
2.2.10.6 'density' = 0.094 (g/cm3)
2.2.10.7 'diameter' = 0.03 (cm)
2.2.10.8 'gravitropism' = 0 (noUnit)
2.2.10.9 'gravitropism.v2' = 0 0 0 (cm)
2.2.10.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.768 2 0.768 4 0.768 6 0.768 10 0 1000 0}
2.2.10.11 'longitudinal growth rate multiplier' (cm) minimum=0.8 maximum=1.2 mean=1 stdev=0.1
2.2.10.12 'nitrate'

2.2.10.12.1 ' Cmin' = 0.001 (uMol/ml)
2.2.10.12.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.10.12.3 ' Km' = 0.0161 (uMol/ml)
2.2.10.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.10.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.10.13 'number of xylem poles' = 4 (noUnit)
2.2.10.14 'phosphorus'

2.2.10.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.10.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.10.14.3 ' Km' = 0.00545 (uMol/ml)
2.2.10.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.10.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.10.15 'potassium'

2.2.10.15.1 ' Cmin' = 0.002 (uMol/ml)
2.2.10.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.10.15.3 ' Km' = 0.039 (uMol/ml)
2.2.10.15.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.10.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.10.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.10.17 'regular topology' = 0 (noUnit)
2.2.10.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }

2.2.10.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.10.20 'root class ID' = 97 (noUnit)
2.2.10.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 10 2000 30 2000 100 2000 }
2.2.10.22 'root hair diameter' = 0.0005 (cm)
2.2.10.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.10.24 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.2.10.25 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 0.1 50 0.1 100 0.1 }
2.2.10.26 'soil impedence' = 0.02 (noUnit)
2.2.10.27 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.2 maximum=0.2
2.2.10.28 'top boundary' = 1 (noUnit)
2.2.10.29 'topology offset' = 0 (noUnit)

2.2.11 'lateral primary root fast growing'

2.2.11.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.11.2 'bottom boundary' = 1 (noUnit)
2.2.11.3 'bounce of the side' = 1 (noUnit)
2.2.11.4 'branch list'

2.2.11.4.1 'finelateral fast growing'

2.2.11.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.2.11.4.1.2 'branching frequency' = 0.55 (cm)
2.2.11.4.1.3 'length root tip' = 4 (cm)

2.2.11.5 'branching angle' = 75 (degrees)
2.2.11.6 'density' = 0.094 (g/cm3)
2.2.11.7 'diameter' = 0.03 (cm)
2.2.11.8 'gravitropism' = 0 (noUnit)
2.2.11.9 'gravitropism.v2' = 0 0 0 (cm)
2.2.11.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.768 2 0.768 15 0.768 20 0 1000 0 }
2.2.11.11 'longitudinal growth rate multiplier' (cm) minimum=1.4 maximum=1.8 mean=1.6 stdev=0.2
2.2.11.12 'nitrate'

2.2.11.12.1 ' Cmin' = 0.001 (uMol/ml)
2.2.11.12.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.11.12.3 ' Km' = 0.0161 (uMol/ml)
2.2.11.12.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.11.12.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.11.13 'number of xylem poles' = 4 (noUnit)
2.2.11.14 'phosphorus'

2.2.11.14.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.11.14.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.11.14.3 ' Km' = 0.00545 (uMol/ml)
2.2.11.14.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.11.14.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.11.15 'potassium'

2.2.11.15.1 ' Cmin' = 0.002 (uMol/ml)
2.2.11.15.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.11.15.3 ' Km' = 0.039 (uMol/ml)
2.2.11.15.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.11.15.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.11.16 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.11.17 'regular topology' = 0 (noUnit)
2.2.11.18 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.11.19 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.11.20 'root class ID' = 97 (noUnit)
2.2.11.21 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.2.11.22 'root hair diameter' = 0.0005 (cm)
2.2.11.23 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.11.24 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.2.11.25 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 0.3 50 0.2 100 0.2 }
2.2.11.26 'soil impedence' = 0.02 (noUnit)

2.2.11.27 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.2.11.28 'top boundary' = 1 (noUnit)
2.2.11.29 'topology offset' = 0 (noUnit)

2.2.12 'primary root'

2.2.12.1 'aerenchyma formation' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0 3 0 5 0.05 10 0.1 20 0.268 1000 0.268 }
2.2.12.2 'bottom boundary' = 1 (noUnit)
2.2.12.3 'bounce of the side' = 1 (noUnit)
2.2.12.4 'branch list'

2.2.12.4.1 'lateral primary root'

2.2.12.4.1.1 'allow branches to form above ground' = 0 (noUnit)
2.2.12.4.1.2 'branching frequency' = 0.1 (cm)
2.2.12.4.1.3 'length root tip' = 10 (cm)
2.2.12.4.1.4 'number of branches/whorl' = 1 (#)

2.2.12.4.2 'lateral primary root fast growing'

2.2.12.4.2.1 'allow branches to form above ground' = 0 (noUnit)
2.2.12.4.2.2 'branching frequency' (cm) minimum=1 maximum=5
2.2.12.4.2.3 'length root tip' = 10 (cm)
2.2.12.4.2.4 'number of branches/whorl' = 1 (#)

2.2.12.5 'branching angle' = 0 (degrees)
2.2.12.6 'density' = 0.094 (g/cm3)
2.2.12.7 'diameter' = 0.09 (cm)
2.2.12.8 'gravitropism' = 0.011 (noUnit)
2.2.12.9 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.015 maximum=-0.005
2.2.12.10 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 2.357 10 2.357 15 2.357 250 2.357 }
2.2.12.11 'nitrate'

2.2.12.11.1 ' Cmin' = 0.001 (uMol/ml)
2.2.12.11.2 ' Imax' = 1.9 (uMol/cm2/day)
2.2.12.11.3 ' Km' = 0.0161 (uMol/ml)
2.2.12.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.2.12.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.2.12.12 'number of xylem poles' = 16 (noUnit)
2.2.12.13 'phosphorus'

2.2.12.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.2.12.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.2.12.13.3 ' Km' = 0.00545 (uMol/ml)
2.2.12.13.4 'minimal nutrient concentration' = 30 (uMol/g)
2.2.12.13.5 'optimal nutrient concentration' = 60 (uMol/g)

2.2.12.14 'potassium'

2.2.12.14.1 ' Cmin' = 0.002 (uMol/ml)
2.2.12.14.2 ' Imax' = 0.467 (uMol/cm2/day)
2.2.12.14.3 ' Km' = 0.039 (uMol/ml)
2.2.12.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.2.12.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.2.12.15 'reduction in respiration due to aerenchyma' (100%) =f{'aerenchymaFormation'} (100%) x,y pairs :{ 0 0 0.3 0.7 0.6 1 }
2.2.12.16 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.2.12.17 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.2.12.18 'root class ID' = 100 (noUnit)
2.2.12.19 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 10 2000 30 2000 100 2000 }
2.2.12.20 'root hair diameter' = 0.0005 (cm)
2.2.12.21 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.03 100 0.03 }
2.2.12.22 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.2.12.23 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 4 0.5 4 1 4 20 4 40 2 100 2 }
2.2.12.24 'soil impedence' = 0.01 (noUnit)
2.2.12.25 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.2.12.26 'top boundary' = 1 (noUnit)

2.2.13 'resources'

2.2.13.1 ' cto dry weight ratio' = 0.45 (100%)

2.2.13.2 'carbon allocation2 leafs factor' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 0.7 10 0.65 30 0.65 40 0.65 60 0.4 }
2.2.13.3 'carbon allocation2 roots factor' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 1 1 0.5 5 0.2 1000 0.2 }
2.2.13.4 'carbon cost of biologcial nitrogen fixation' = 3.95e-05 (g/uMol)
2.2.13.5 'carbon cost of nitrate uptake' = 1.392e-05 (g/uMol)
2.2.13.6 'max carbon allocation2 secondary growth' = 0.7 (100%)
2.2.13.7 'max carbon allocation2 shoot' = 0.85 (100%)
2.2.13.8 'nitrate'

2.2.13.8.1 'initial nutrient uptake' = 714 (uMol)

2.2.13.9 'phosphorus'

2.2.13.9.1 'initial nutrient uptake' = 39 (uMol)

2.2.13.10 'potassium'

2.2.13.10.1 'initial nutrient uptake' = 45 (uMol)

2.2.13.11 'relative reliance on b n f' = 30 (100%)
2.2.13.12 'reserve allocation rate' (100%/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.4 2 0.4 3 0.4 4 0.4 1000 0.4 }
2.2.13.13 'seed size' = 0.2 (g)

2.2.14 'shoot'

2.2.14.1 'aerenchyma photosynthesis mitigation' = 0.5 (100%)
2.2.14.2 'area per plant' = 660 (cm2)
2.2.14.3 'extinction coefficient' = 0.9 (noUnit)
2.2.14.4 'leaf area expantion rate' (cm2/day) =f{'time'} (day) x,y pairs :{ 0 0 2 0 3 3 4 5 6 5 7.04 3.91 7.29 4.21 7.55 4.52 7.8 4.85 8.05 5.19 8.3 5.54 8.56 5.92 8.81 6.31 9.06 6.72 9.31 7.14 9.57 7.59 9.82 8.06 10.07 8.55 10.32 9.06 10.58 9.59 10.83 10.15 11.08 10.74 11.33 11.35 11.59 11.99 11.84 12.66 12.09 13.36 12.34 14.09 12.6 14.85 12.85 15.65 13.1 16.49 13.35 17.37 13.61 18.28 13.86 19.24 14.11 20.24 14.36 21.29 14.62 22.39 14.87 23.53 15.12 24.73 15.37 25.98 15.63 27.3 15.88 28.67 16.13 30.1 16.38 31.6 16.64 33.17 16.89 34.81 17.14 36.53 17.39 38.32 17.65 40.2 17.9 42.16 18.15 44.21 18.4 46.36 18.66 48.61 18.91 50.96 19.16 53.41 19.41 55.98 19.67 58.67 19.92 61.48 20.17 64.42 20.42 67.49 20.68 70.71 20.93 74.07 21.18 77.59 21.43 81.27 21.69 85.12 21.94 89.14 22.19 93.35 22.44 97.75 22.7 102.35 22.95 107.17 23.2 112.2 23.45 117.47 23.71 122.98 23.96 128.74 24.21 134.76 24.46 141.06 24.72 147.65 24.97 154.55 25.29 156.06 25.66 154.09 26.02 152.11 26.38 150.11 26.74 148.1 27.1 146.08 27.46 144.05 27.83 142.02 28.19 139.98 28.55 137.94 28.91 135.9 29.27 133.85 29.63 131.81 29.99 129.77 30.36 127.73 30.72 125.7 31.08 123.67 31.44 121.65 31.8 119.64 32.16 117.64 32.52 115.65 32.89 113.67 33.25 111.71 33.61 109.75 33.97 107.81 34.33 105.89 34.69 103.98 35.06 102.09 35.42 100.21 35.78 98.36 36.14 96.52 36.5 94.7 36.86 92.9 37.22 91.12 37.59 89.36 37.95 87.62 38.31 85.9 38.67 84.2 39.03 82.53 39.39 80.87 39.76 79.24 40.12 77.63 40.48 76.05 40.84 74.49 41.2 72.95 41.56 71.43 41.92 69.94 42.29 68.47 42.65 67.02 43.01 65.59 43.37 64.19 43.73 62.82 44.09 61.46 44.45 60.13 44.82 58.82 45.18 57.53 45.54 56.27 45.9 55.03 46.26 53.81 46.62 52.61 46.99 51.44 47.35 50.29 47.71 49.16 48.07 48.05 48.43 46.96 48.79 45.89 49.15 44.84 49.52 43.82 49.88 42.81 50.24 41.83 50.6 40.86 50.96 39.91 51.32 38.99 51.69 38.08 52.05 37.19 52.41 36.32 52.77 35.47 53.13 34.63 53.49 33.82 53.85 33.02 54.22 32.23 54.58 31.47 54.94 30.72 55.3 29.99 55.66 29.27 56.02 28.57 56.38 27.88 56.75 27.21 57.11 26.56 57.47 25.92 57.83 25.29 58.19 24.68 58.55 24.08 58.92 23.49 59.28 22.92 59.64 22.36 }
2.2.14.5 'light use efficiency' = 3.8e-07 (g/uMol)
2.2.14.6 'nitrate'

2.2.14.6.1 'leaf minimal nutrient concentration' = 1300 (uMol/g)
2.2.14.6.2 'leaf optimal nutrient concentration' = 2600 (uMol/g)
2.2.14.6.3 'stem minimal nutrient concentration' = 700 (uMol/g)
2.2.14.6.4 'stem optimal nutrient concentration' = 1300 (uMol/g)

2.2.14.7 'phosphorus'

2.2.14.7.1 'leaf minimal nutrient concentration' = 50 (uMol/g)
2.2.14.7.2 'leaf optimal nutrient concentration' = 100 (uMol/g)
2.2.14.7.3 'stem minimal nutrient concentration' = 25 (uMol/g)
2.2.14.7.4 'stem optimal nutrient concentration' = 50 (uMol/g)

2.2.14.8 'potassium'

2.2.14.8.1 'leaf minimal nutrient concentration' = 273 (uMol/g)
2.2.14.8.2 'leaf optimal nutrient concentration' = 430 (uMol/g)
2.2.14.8.3 'stem minimal nutrient concentration' = 273 (uMol/g)
2.2.14.8.4 'stem optimal nutrient concentration' = 215 (uMol/g)

2.2.14.9 'relative potential transpiration' = 100 (cm3/g)
2.2.14.10 'relative respiration rate leafs' = 0.04 (g/g/day)
2.2.14.11 'relative respiration rate stems' = 0.02 (g/g/day)
2.2.14.12 'specific leaf area' (g/cm2) =f{'time'} (day) x,y pairs :{ 0 0.0015 24 0.0025 40 0.003 60 0.003 }

2.2.15 'stress impact factors'

2.2.15.1 'impact on:leaf area expantion rate'

2.2.15.1.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 0.3 0.1 1 1 }
2.2.15.1.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.2.15.1.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }

2.2.15.2 'impact on:photosynthesis'

2.2.15.2.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 0.4 0.5 1 1 }
2.2.15.2.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0.5 1 1 }
2.2.15.2.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }

2.2.15.3 'impact on:root segment carbon cost of exudates'

2.2.15.3.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.2.15.3.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.2.15.3.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }

2.2.15.4 'impact on:root segment respiration'

2.2.15.4.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.2.15.4.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.2.15.4.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }

2.2.15.5 'impact on:root segment secondary growth'

2.2.15.5.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.2.15.5.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.2.15.5.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }

2.3 'squash'

2.3.1 'finelateral'

2.3.1.1 'bottom boundary' = 1 (noUnit)
2.3.1.2 'bounce of the side' = 1 (noUnit)
2.3.1.3 'branch list'
2.3.1.4 'branching angle' = 75 (degrees)
2.3.1.5 'density' = 0.1 (g/cm3)
2.3.1.6 'diameter' = 0.01 (cm)
2.3.1.7 'gravitropism' = 0 (noUnit)
2.3.1.8 'gravitropism.v2' = 0 0 0 (cm)
2.3.1.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.2 3 0.2 5 0 100 0 }
2.3.1.10 'longitudinal growth rate multiplier' (cm) minimum=0.3 maximum=1
2.3.1.11 'nitrate'

2.3.1.11.1 ' Cmin' = 0.001 (uMol/ml)
2.3.1.11.2 ' Imax' = 15.3 (uMol/cm2/day)
2.3.1.11.3 ' Km' = 0.015 (uMol/ml)
2.3.1.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.3.1.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.3.1.12 'number of xylem poles' = 4 (noUnit)
2.3.1.13 'phosphorus'

2.3.1.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.3.1.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.3.1.13.3 ' Km' = 0.00545 (uMol/ml)
2.3.1.13.4 'exudates factor' = 4 (noUnit)
2.3.1.13.5 'minimal nutrient concentration' = 30 (uMol/g)
2.3.1.13.6 'optimal nutrient concentration' = 60 (uMol/g)

2.3.1.14 'potassium'

2.3.1.14.1 ' Cmin' = 0.002 (uMol/ml)
2.3.1.14.2 ' Imax' = 1 (uMol/cm2/day)
2.3.1.14.3 ' Km' = 0.028 (uMol/ml)
2.3.1.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.3.1.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.3.1.15 'regular topology' = 0 (noUnit)
2.3.1.16 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.3.1.17 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.3.1.18 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.3.1.19 'root hair diameter' = 0.0005 (cm)
2.3.1.20 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.05 100 0.05 }
2.3.1.21 'soil impedence' = 0.5 (noUnit)
2.3.1.22 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.3.1.23 'topology offset' = 0 (noUnit)

2.3.2 'finelateral fast growing'

2.3.2.1 'bottom boundary' = 1 (noUnit)
2.3.2.2 'bounce of the side' = 1 (noUnit)
2.3.2.3 'branch list'

2.3.2.3.1 'finelateral'

2.3.2.3.1.1 'branching frequency' = 0.32 (cm)
2.3.2.3.1.2 'length root tip' = 1 (cm)

2.3.2.4 'branching angle' = 75 (degrees)
2.3.2.5 'density' = 0.1 (g/cm3)
2.3.2.6 'diameter' = 0.015 (cm)
2.3.2.7 'gravitropism' = 0 (noUnit)
2.3.2.8 'gravitropism.v2' = 0 0 0 (cm)
2.3.2.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.5 1 0.8 2 1 3 1 4 0 100 0 }
2.3.2.10 'longitudinal growth rate multiplier' (cm) minimum=0.3 maximum=1
2.3.2.11 'nitrate'

2.3.2.11.1 ' Cmin' = 0.001 (uMol/ml)
2.3.2.11.2 ' Imax' = 15.3 (uMol/cm2/day)
2.3.2.11.3 ' Km' = 0.015 (uMol/ml)
2.3.2.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.3.2.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.3.2.12 'number of xylem poles' = 4 (noUnit)
2.3.2.13 'phosphorus'

2.3.2.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.3.2.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.3.2.13.3 ' Km' = 0.00545 (uMol/ml)
2.3.2.13.4 'exudates factor' = 4 (noUnit)
2.3.2.13.5 'minimal nutrient concentration' = 30 (uMol/g)
2.3.2.13.6 'optimal nutrient concentration' = 60 (uMol/g)

2.3.2.14 'potassium'

2.3.2.14.1 ' Cmin' = 0.002 (uMol/ml)
2.3.2.14.2 ' Imax' = 1 (uMol/cm2/day)
2.3.2.14.3 ' Km' = 0.028 (uMol/ml)
2.3.2.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.3.2.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.3.2.15 'regular topology' = 0 (noUnit)
2.3.2.16 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8
1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.3.2.17 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.3.2.18 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.3.2.19 'root hair diameter' = 0.0005 (cm)
2.3.2.20 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.05 100 0.05 }
2.3.2.21 'soil impedence' = 0.5 (noUnit)
2.3.2.22 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.3.2.23 'topology offset' = 0 (noUnit)

2.3.3 'hypocotyl'

2.3.3.1 'bottom boundary' = 1 (noUnit)
2.3.3.2 'bounce of the side' = 1 (noUnit)
2.3.3.3 'branch list'

2.3.3.3.1 'lateral primary root fast growing'

2.3.3.3.1.1 'allow branches to form above ground' = 0 (noUnit)
2.3.3.3.1.2 'branching frequency' = 0.5 (cm)
2.3.3.3.1.3 'branching time offset' = 10 (day)
2.3.3.3.1.4 'number of branches/whorl' = 1 (#)

2.3.3.4 'density' = 0.1 (g/cm3)
2.3.3.5 'diameter' = 0.3 (cm)
2.3.3.6 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=0.5 maximum=0.6
2.3.3.7 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.1 1 0.5 1.3 1 1.5 2.3 2 3 2.5 3 3 2.3 3.5 1
4 0.2 5 0 1000 0 }
2.3.3.8 'nitrate'

2.3.3.8.1 ' Cmin' = 0.001 (uMol/ml)
2.3.3.8.2 ' Imax' = 15.3 (uMol/cm2/day)
2.3.3.8.3 ' Km' = 0.015 (uMol/ml)

2.3.3.8.4 'minimal nutrient concentration' = 600 (uMol/g)
2.3.3.8.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.3.3.9 'number of xylem poles' = 4 (noUnit)
2.3.3.10 'phosphorus'

2.3.3.10.1 ' Cmin' = 0.0002 (uMol/ml)
2.3.3.10.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.3.3.10.3 ' Km' = 0.00545 (uMol/ml)
2.3.3.10.4 'minimal nutrient concentration' = 30 (uMol/g)
2.3.3.10.5 'optimal nutrient concentration' = 60 (uMol/g)

2.3.3.11 'potassium'

2.3.3.11.1 ' Cmin' = 0.002 (uMol/ml)
2.3.3.11.2 ' Imax' = 1 (uMol/cm2/day)
2.3.3.11.3 ' Km' = 0.028 (uMol/ml)
2.3.3.11.4 'minimal nutrient concentration' = 168 (uMol/g)
2.3.3.11.5 'optimal nutrient concentration' = 234 (uMol/g)

2.3.3.12 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.3.3.13 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.3.3.14 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 0 100 0 }
2.3.3.15 'root hair diameter' = 0.0005 (cm)
2.3.3.16 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.05 100 0.05 }
2.3.3.17 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 10 0 15 0.0015 17 0.002 20 0.0023 24 0.0026 27 0.00285 32 0.003 100 0.003 }
2.3.3.18 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 20 1000 20 }
2.3.3.19 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.01 maximum=0.01

2.3.4 'hypocotyl born roots'

2.3.4.1 'bottom boundary' = 1 (noUnit)
2.3.4.2 'bounce of the side' = 1 (noUnit)
2.3.4.3 'branch list'

2.3.4.3.1 'lateral hypocotyl born roots'

2.3.4.3.1.1 'branching frequency' = 0.32 (cm)
2.3.4.3.1.2 'length root tip' = 1 (cm)

2.3.4.4 'branching angle' = 85 (degrees)
2.3.4.5 'density' = 0.1 (g/cm3)
2.3.4.6 'diameter' = 0.064 (cm)
2.3.4.7 'gravitropism' = 0 (noUnit)
2.3.4.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.002 maximum=0
2.3.4.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.1 2 1 25 0.8 35 0 60 0 }
2.3.4.10 'longitudinal growth rate multiplier' (cm) minimum=0.5 maximum=1.5
2.3.4.11 'nitrate'

2.3.4.11.1 ' Cmin' = 0.001 (uMol/ml)
2.3.4.11.2 ' Imax' = 15.3 (uMol/cm2/day)
2.3.4.11.3 ' Km' = 0.015 (uMol/ml)
2.3.4.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.3.4.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.3.4.12 'number of xylem poles' = 4 (noUnit)
2.3.4.13 'phosphorus'

2.3.4.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.3.4.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.3.4.13.3 ' Km' = 0.00545 (uMol/ml)
2.3.4.13.4 'exudates factor' = 4 (noUnit)
2.3.4.13.5 'minimal nutrient concentration' = 30 (uMol/g)
2.3.4.13.6 'optimal nutrient concentration' = 60 (uMol/g)

2.3.4.14 'potassium'

2.3.4.14.1 ' Cmin' = 0.002 (uMol/ml)
2.3.4.14.2 ' Imax' = 1 (uMol/cm2/day)
2.3.4.14.3 ' Km' = 0.028 (uMol/ml)
2.3.4.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.3.4.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.3.4.15 'regular topology' = 0 (noUnit)
2.3.4.16 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.3.4.17 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }

2.3.4.18 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 10 3000 30 3000 100 3000 }
2.3.4.19 'root hair diameter' = 0.0005 (cm)
2.3.4.20 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.05 100 0.05 }
2.3.4.21 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 4 0.0005 5 0.001 7 0.0015 11 0.002 13 0.0023 18 0.0026 24 0.00285 29 0.003 100 0.003 }
2.3.4.22 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 0.6 50 0.2 100 0.2 }
2.3.4.23 'soil impedence' = 0.003 (noUnit)
2.3.4.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.04 maximum=0.04

2.3.5 'lateral hypocotyl born roots'

2.3.5.1 'bottom boundary' = 1 (noUnit)
2.3.5.2 'bounce of the side' = 1 (noUnit)
2.3.5.3 'branch list'
2.3.5.4 'branching angle' = 75 (degrees)
2.3.5.5 'density' = 0.1 (g/cm3)
2.3.5.6 'diameter' = 0.03 (cm)
2.3.5.7 'gravitropism' = 0 (noUnit)
2.3.5.8 'gravitropism.v2' = 0 0 0 (cm)
2.3.5.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.768 2 0.768 4 0.768 6 0.2 10 0 1000 0 }
2.3.5.10 'longitudinal growth rate multiplier' (cm) minimum=0.6 maximum=1
2.3.5.11 'nitrate'

2.3.5.11.1 ' Cmin' = 0.001 (uMol/ml)
2.3.5.11.2 ' Imax' = 15.3 (uMol/cm2/day)
2.3.5.11.3 ' Km' = 0.015 (uMol/ml)
2.3.5.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.3.5.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.3.5.12 'number of xylem poles' = 4 (noUnit)
2.3.5.13 'phosphorus'

2.3.5.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.3.5.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.3.5.13.3 ' Km' = 0.00545 (uMol/ml)
2.3.5.13.4 'exudates factor' = 4 (noUnit)
2.3.5.13.5 'minimal nutrient concentration' = 30 (uMol/g)
2.3.5.13.6 'optimal nutrient concentration' = 60 (uMol/g)

2.3.5.14 'potassium'

2.3.5.14.1 ' Cmin' = 0.002 (uMol/ml)
2.3.5.14.2 ' Imax' = 1 (uMol/cm2/day)
2.3.5.14.3 ' Km' = 0.028 (uMol/ml)
2.3.5.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.3.5.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.3.5.15 'regular topology' = 0 (noUnit)
2.3.5.16 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.3.5.17 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.3.5.18 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.3.5.19 'root hair diameter' = 0.0005 (cm)
2.3.5.20 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.05 100 0.05 }
2.3.5.21 'soil impedence' = 0.015 (noUnit)
2.3.5.22 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.3.5.23 'topology offset' = 0 (noUnit)

2.3.6 'lateral primary root'

2.3.6.1 'bottom boundary' = 1 (noUnit)
2.3.6.2 'bounce of the side' = 1 (noUnit)
2.3.6.3 'branch list'

2.3.6.3.1 'finelateral'

2.3.6.3.1.1 'branching frequency' = 0.32 (cm)
2.3.6.3.1.2 'length root tip' = 1.5 (cm)

2.3.6.4 'branching angle' = 75 (degrees)
2.3.6.5 'density' = 0.1 (g/cm3)
2.3.6.6 'diameter' = 0.027 (cm)
2.3.6.7 'gravitropism' = 0 (noUnit)
2.3.6.8 'gravitropism.v2' = 0 0 0 (cm)
2.3.6.9 'growth rate' (cm/day) =f{'time since creation of primordia'} (day) x,y pairs :{ 0 0.1 2 0.6 10 0.6 15 0.01 1000

0.01 }
2.3.6.10 'longitudinal growth rate multiplier' (cm) minimum=0.2 maximum=3 mean=1.4 stdev=0.5
2.3.6.11 'nitrate'

2.3.6.11.1 ' Cmin' = 0.001 (uMol/ml)
2.3.6.11.2 ' Imax' = 15.3 (uMol/cm2/day)
2.3.6.11.3 ' Km' = 0.015 (uMol/ml)
2.3.6.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.3.6.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.3.6.12 'number of xylem poles' = 4 (noUnit)
2.3.6.13 'phosphorus'

2.3.6.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.3.6.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.3.6.13.3 ' Km' = 0.00545 (uMol/ml)
2.3.6.13.4 'exudates factor' = 4 (noUnit)
2.3.6.13.5 'minimal nutrient concentration' = 30 (uMol/g)
2.3.6.13.6 'optimal nutrient concentration' = 60 (uMol/g)

2.3.6.14 'potassium'

2.3.6.14.1 ' Cmin' = 0.002 (uMol/ml)
2.3.6.14.2 ' Imax' = 1 (uMol/cm2/day)
2.3.6.14.3 ' Km' = 0.028 (uMol/ml)
2.3.6.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.3.6.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.3.6.15 'regular topology' = 0 (noUnit)
2.3.6.16 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.3.6.17 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.3.6.18 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 10 2000 30 2000 100 2000 }
2.3.6.19 'root hair diameter' = 0.0005 (cm)
2.3.6.20 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.05 100 0.05 }
2.3.6.21 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 10 0 14 0.0005 15 0.001 17 0.0015 21 0.002 23 0.0023 28 0.0026 34 0.00285 39 0.003 100 0.003 }
2.3.6.22 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 0.05 50 0.05 100 0.05 }
2.3.6.23 'soil impedence' = 0.02 (noUnit)
2.3.6.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.2 maximum=0.2
2.3.6.25 'topology offset' = 0 (noUnit)

2.3.7 'lateral primary root fast growing'

2.3.7.1 'bottom boundary' = 1 (noUnit)
2.3.7.2 'bounce of the side' = 1 (noUnit)
2.3.7.3 'branch list'

2.3.7.3.1 'finelateral'

2.3.7.3.1.1 'branching frequency' = 0.32 (cm)
2.3.7.3.1.2 'length root tip' = 4 (cm)

2.3.7.3.2 'finelateral fast growing'

2.3.7.3.2.1 'branching frequency' = 0.7 (cm)
2.3.7.3.2.2 'length root tip' = 4 (cm)

2.3.7.4 'branching angle' = 75 (degrees)
2.3.7.5 'density' = 0.1 (g/cm3)
2.3.7.6 'diameter' = 0.047 (cm)
2.3.7.7 'gravitropism' = 0 (noUnit)
2.3.7.8 'gravitropism.v2' (cm) =f{'normal distribution'} mean=-0.001 stdev=0.01
2.3.7.9 'growth rate' (cm/day) =f{'time since creation of primordia'} (day) x,y pairs :{ 0 0.1 3 0.6 5 1.3 10 2 25 2 30 2 1000 2 }
2.3.7.10 'longitudinal growth rate multiplier' (cm) minimum=0.2 maximum=2 mean=1 stdev=0.4
2.3.7.11 'nitrate'

2.3.7.11.1 ' Cmin' = 0.001 (uMol/ml)
2.3.7.11.2 ' Imax' = 15.3 (uMol/cm2/day)
2.3.7.11.3 ' Km' = 0.015 (uMol/ml)
2.3.7.11.4 'minimal nutrient concentration' = 600 (uMol/g)
2.3.7.11.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.3.7.12 'number of xylem poles' = 4 (noUnit)
2.3.7.13 'phosphorus'

2.3.7.13.1 ' Cmin' = 0.0002 (uMol/ml)
2.3.7.13.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.3.7.13.3 ' Km' = 0.00545 (uMol/ml)
2.3.7.13.4 'exudates factor' = 2 (noUnit)
2.3.7.13.5 'minimal nutrient concentration' = 30 (uMol/g)
2.3.7.13.6 'optimal nutrient concentration' = 60 (uMol/g)

2.3.7.14 'potassium'

2.3.7.14.1 ' Cmin' = 0.002 (uMol/ml)
2.3.7.14.2 ' Imax' = 1 (uMol/cm2/day)
2.3.7.14.3 ' Km' = 0.028 (uMol/ml)
2.3.7.14.4 'minimal nutrient concentration' = 168 (uMol/g)
2.3.7.14.5 'optimal nutrient concentration' = 234 (uMol/g)

2.3.7.15 'regular topology' = 0 (noUnit)
2.3.7.16 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.3.7.17 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.3.7.18 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 3000 100 3000 }
2.3.7.19 'root hair diameter' = 0.0005 (cm)
2.3.7.20 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.05 100 0.05 }
2.3.7.21 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 10 0 14 0.0005 15 0.001 17 0.0015 21 0.002 23 0.0023 28 0.0026 34 0.00285 39 0.003 100 0.003 }
2.3.7.22 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 6 20 5 50 2 100 1 1000 1 }
2.3.7.23 'soil impedence' = 0.02 (noUnit)
2.3.7.24 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.08 maximum=0.08
2.3.7.25 'topology offset' = 0 (noUnit)

2.3.8 'primary root'

2.3.8.1 'bottom boundary' = 1 (noUnit)
2.3.8.2 'bounce of the side' = 1 (noUnit)
2.3.8.3 'branch list'

2.3.8.3.1 'lateral primary root'

2.3.8.3.1.1 'branching frequency' = 0.5 (cm)
2.3.8.3.1.2 'length root tip' = 6 (cm)
2.3.8.3.1.3 'number of branches/whorl' = 1 (#)

2.3.8.3.2 'lateral primary root fast growing'

2.3.8.3.2.1 'branching frequency' (cm) =f{'relative time creation last branch'} (day) x,y pairs :{ 0 0.5 10 1 20 10 30 500 1000 500 }
2.3.8.3.2.2 'length root tip' = 6 (cm)
2.3.8.3.2.3 'number of branches/whorl' = 1 (#)

2.3.8.4 'branching angle' = 0 (degrees)
2.3.8.5 'density' = 0.1 (g/cm3)
2.3.8.6 'diameter' = 0.07 (cm)
2.3.8.7 'gravitropism' = 0.011 (noUnit)
2.3.8.8 'gravitropism.v2' (cm) =f{'uniform distribution'} minimum=-0.015 maximum=-0.005
2.3.8.9 'growth rate' (cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 4 250 4 }
2.3.8.10 'nitrate'

2.3.8.10.1 ' Cmin' = 0.001 (uMol/ml)
2.3.8.10.2 ' Imax' = 15.3 (uMol/cm2/day)
2.3.8.10.3 ' Km' = 0.015 (uMol/ml)
2.3.8.10.4 'minimal nutrient concentration' = 600 (uMol/g)
2.3.8.10.5 'optimal nutrient concentration' = 1200 (uMol/g)

2.3.8.11 'number of xylem poles' = 16 (noUnit)
2.3.8.12 'phosphorus'

2.3.8.12.1 ' Cmin' = 0.0002 (uMol/ml)
2.3.8.12.2 ' Imax' = 0.0555 (uMol/cm2/day)
2.3.8.12.3 ' Km' = 0.00545 (uMol/ml)
2.3.8.12.4 'exudates factor' = 2 (noUnit)
2.3.8.12.5 'minimal nutrient concentration' = 30 (uMol/g)
2.3.8.12.6 'optimal nutrient concentration' = 60 (uMol/g)

2.3.8.13 'potassium'

2.3.8.13.1 ' Cmin' = 0.002 (uMol/ml)
2.3.8.13.2 ' Imax' = 1 (uMol/cm2/day)

2.3.8.13.3 ' Km' = 0.028 (uMol/ml)
2.3.8.13.4 'minimal nutrient concentration' = 168 (uMol/g)
2.3.8.13.5 'optimal nutrient concentration' = 234 (uMol/g)

2.3.8.14 'relative carbon cost of exudation' (g/cm/day) =f{'time since creation'} (day) x,y pairs :{ 0 1.915e-05 1.8 1.511e-05 3.1 1.699e-05 4.4 1.362e-05 100 1.362e-05 }
2.3.8.15 'relative respiration' (g/g/day) =f{'time since creation'} (day) x,y pairs :{ 0 0.09 2 0.04 6 0.04 1000 0.04 }
2.3.8.16 'root hair density' (#/cm2) =f{'time since creation'} (day) x,y pairs :{ 0 2000 10 2000 30 2000 100 2000 }
2.3.8.17 'root hair diameter' = 0.0005 (cm)
2.3.8.18 'root hair length' (cm) =f{'time since creation'} (day) x,y pairs :{ 0 0 1 0 2 0.05 100 0.05 }
2.3.8.19 'secondary growth rate' (cm/day) =f{'root segment age'} (day) x,y pairs :{ 0 0 6 0 10 0 15 0.0015 17 0.002 20 0.0023 24 0.0026 27 0.00285 32 0.003 100 0.003 }
2.3.8.20 'secondary growth scaling factor' (100%) =f{'distance to base of the root'} (cm) x,y pairs :{ 0 20 10 10 20 4 100 2 300 1 1000 1 }
2.3.8.21 'soil impedence' = 0.01 (noUnit)
2.3.8.22 'soil impedence.v2' (cm) =f{'uniform distribution'} minimum=-0.05 maximum=0.05

2.3.9 'resources'

2.3.9.1 ' cto dry weight ratio' = 0.41 (100%)
2.3.9.2 'carbon allocation2 leafs factor' (100%) =f{'time since creation'} (day) x,y pairs :{ 0 1 10 0.9 13 0.83 17 0.71 19 0.64 20 0.63 1000 0.63 }
2.3.9.3 'carbon cost of nitrate uptake' = 1.392e-05 (g/uMol)
2.3.9.4 'max carbon allocation2 secondary growth' = 0.7 (100%)
2.3.9.5 'max carbon allocation2 shoot' = 0.83 (100%)
2.3.9.6 'nitrate'

2.3.9.6.1 'initial nutrient uptake' = 428 (uMol)

2.3.9.7 'phosphorus'

2.3.9.7.1 'initial nutrient uptake' = 39 (uMol)

2.3.9.8 'potassium'

2.3.9.8.1 'initial nutrient uptake' = 30 (uMol)

2.3.9.9 'seed size' = 0.2 (g)

2.3.10 'shoot'

2.3.10.1 'area per plant' = 2400 (cm2)
2.3.10.2 'extinction coefficient' = 1 (noUnit)
2.3.10.3 'leaf area expantion rate' (cm2/day) =f{'time'} (day) x,y pairs :{ 0 0 1 0 2 1 3 1 4 1 5 1 6 2 7 3 8 4.5 9 6 10 10 11 12 12 14 13 16 14 20 15 25 16.5 31 18 45 19 60 20 90 21 130 22 155 23 175 24 195 25 215 26 230 27 245 28 260 29 275 30 290 31 305 32 320 33 335 34 350 35 365 36 380 37 395 38 410 39 425 40 440 41 455 42 470 43 485 44 500 45 515 46 530 }
2.3.10.4 'light use efficiency' = 3.8e-07 (g/uMol)
2.3.10.5 'nitrate'

2.3.10.5.1 'leaf minimal nutrient concentration' = 1500 (uMol/g)
2.3.10.5.2 'leaf optimal nutrient concentration' = 2714 (uMol/g)
2.3.10.5.3 'stem minimal nutrient concentration' = 1500 (uMol/g)
2.3.10.5.4 'stem optimal nutrient concentration' = 2714 (uMol/g)

2.3.10.6 'phosphorus'

2.3.10.6.1 'leaf minimal nutrient concentration' = 45 (uMol/g)
2.3.10.6.2 'leaf optimal nutrient concentration' = 90 (uMol/g)
2.3.10.6.3 'stem minimal nutrient concentration' = 30 (uMol/g)
2.3.10.6.4 'stem optimal nutrient concentration' = 60 (uMol/g)

2.3.10.7 'potassium'

2.3.10.7.1 'leaf minimal nutrient concentration' = 273 (uMol/g)
2.3.10.7.2 'leaf optimal nutrient concentration' = 430 (uMol/g)
2.3.10.7.3 'stem minimal nutrient concentration' = 273 (uMol/g)
2.3.10.7.4 'stem optimal nutrient concentration' = 215 (uMol/g)

2.3.10.8 'relative potential transpiration' = 100 (cm3/g)
2.3.10.9 'relative respiration rate leafs' = 0.04 (g/g/day)
2.3.10.10 'relative respiration rate stems' = 0.02 (g/g/day)
2.3.10.11 'specific leaf area' (g/cm2) =f{'time'} (day) x,y pairs :{ 0 0.0012 10 0.0012 24 0.004 40 0.005 60 0.005 }

2.3.11 'stress impact factors'

2.3.11.1 'impact on:leaf area expantion rate'

2.3.11.1.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 0.4 0.1 1 1 }
2.3.11.1.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.3.11.1.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }

2.3.11.2 'impact on:photosynthesis'

2.3.11.2.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 0.4 0.5 1 1 }
2.3.11.2.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0.5 1 1 }
2.3.11.2.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }

2.3.11.3 'impact on:root segment carbon cost of exudates'

2.3.11.3.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.3.11.3.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.3.11.3.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }

2.3.11.4 'impact on:root segment respiration'

2.3.11.4.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.3.11.4.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }
2.3.11.4.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 1 1 1 }

2.3.11.5 'impact on:root segment secondary growth'

2.3.11.5.1 'impact by:nitrate' (noUnit) =f{'nitrate stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.3.11.5.2 'impact by:phosphorus' (noUnit) =f{'phosphorus stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }
2.3.11.5.3 'impact by:potassium' (noUnit) =f{'potassium stress factor'} (noUnit) x,y pairs :{ 0 0 1 1 }

(C) Description of new modules added to SimRoot

Biological nitrogen fixation module

Bean is able to acquire 20-60% of its nitrogen through symbioses with nitrogen fixing bacteria (Tsai *et al.*, 1993). We included a simple nitrogen fixation model in *SimRoot* which allows bean to acquire part of its nitrogen demand through biological nitrogen fixation. We made biological nitrogen fixation a fixed proportion (30% for bean) of the optimal nitrogen requirement for plant growth. This means that in unstressed plants less than 30 percent of the acquired nitrogen comes from biological nitrogen fixation while in nitrogen deficient plants this proportion increases. For example in plants where the internal nitrogen content is only 50% of the optimal nitrogen content, 60% of the acquired nitrogen comes from biological nitrogen fixation. This increased reliance on biological nitrogen fixation agrees with the literature (Liu *et al.*, 2011). However, bean growth is still reduced by low nitrogen. The carbon cost of biological nitrogen fixation in the model is 39.5 g C.mol N^{-1} fixed. Estimates of the carbon cost of biological nitrogen fixation in the literature vary from 19.6 – 119 g C.mol N^{-1} fixed (Liu *et al.*, 2011). There are no effects of biological nitrogen fixation on nitrogen uptake rates in the model as the literature does not agree on parallel regulation of nitrogen fixation and nitrogen uptake (Soussana *et al.*, 2002).

Root exudate module

Root exudates may increase phosphorus uptake by solubilizing phosphorus attached to iron, calcium or aluminum complexes, or esterified with organic compounds. Comparing figures from several studies suggests that amount of exudates differ per crop in the order squash > bean > maize (Pellet *et al.*, 1995; Jones, 1998; Shen *et al.*, 2002; Gent *et al.*, 2005; Li *et al.*, 2007). Citrate may be the strongest phosphorus mobilizing carboxylate (Shen *et al.*, 2002). Gerke (1992) found that 20 μmol citrate per gram soil might increase the dissolved phosphorus concentration nearly 100, 10 and 4 times in a

podzol, luvisol and oxisol, respectively, but that higher concentrations of citrate resulted in less than proportional increases in extractable phosphorus. However, concentrations of exudates in the exudate zones of maize bean and squash are likely to be less than 1 μmol citrate per gram soil (Jones, 1998; Raynaud, 2010). This raises questions about the significance of exudates for phosphorus uptake in these crops (Neumann and Römheld, 2000; Ryan *et al.*, 2001). Indeed Pearse *et al.*, (2007) did not find a correlation between the amount and composition of the carboxylate exudates of several species and their ability to utilize various forms of sparingly soluble phosphorus. They conclude that besides exudates other factors such as rhizosphere acidification and root morphology may be important for the uptake of phosphorus from sparingly soluble forms. Darrah *et al.* (2006) conclude that it is problematic to simulate the effects of exudates on phosphorus uptake in relation to the carbon investment into exudates absent a stronger quantitative basis to simulate rhizosphere biology and chemistry. We therefore used an empirical approach to introduce exudates in our model in which we introduced two unrelated parameters : the carbon cost of exudates in g $C \cdot g\ root^{-1} \cdot day^{-1}$ and a unitless solubilization factor which increases the dissolved phosphorus fraction at the cost of the adsorbed fraction. The carbon costs of exudates are based on measurements by Nielsen *et al.* (1994). These measurements may not directly translate to different environments or different plant species. However the cost of exudates was small relative to the respiratory cost of the root system. Imprecision of the estimated cost is likely to have little effect on plant growth. We assumed that exudates of maize and bean had no significant effect on phosphorus availability in the soil, while exudates of squash increased dissolved phosphorus concentrations two times in accordance to measurements of Gent *et al.* (2005).

We were not able to simulate realistic nutrient uptake by squash without the assumption that squash has greater capacity for nutrient uptake (greater Imax) than maize and bean. Greater Imax increases the nutrient uptake for all three nutrients, including phosphorus uptake, since, although phosphorus uptake is more sensitive to the phosphorus diffusion coefficient (Silberbush and Barber, 1983), the sensitivity

of the model to Imax for phosphorus uptake increased when exudates were introduced as discussed above (data not shown). Data from the literature suggests that squash may have greater Imax as Wieneke (1992) measured a Imax for nitrate of 6 to 15 $\mu mol.cm^{-2}.day^{-1}$ in comparison to maize which has an Imax in the range of 2 to 6 $\mu mol.cm^{-2}.day^{-1}$ (Silberbush, University Park, unpublished; Pace and McClure, 1986). In a small hydroponics experiment Zhang (University Park, unpublished) observed a nearly double uptake rate of rubidium, a potassium tracer, in squash plants (0.22 $mg.m^{-1}.week^{-1}$) compared to bean plants (0.13 $mg.m^{-1}.week^{-1}$) while uptake rates of strontium, a calcium tracer, were identical. However uptake rates of rubidium by maize were similar to those of squash in this experiment. Squash remained, despite the simulated ability to have high nutrient acquisition per unit root length, more sensitive to low nutrient availability than maize and bean, which agrees with reports in the literature (Bohnsack and Albert, 1977; Reinbott and Blevins, 1999; Waters and Blevins, 2000) and our own observations of field grown maize bean and squash.

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