Appendix A: SimRoot Parameterization

SimRoot uses a hierarchical xml formatted input file which is graphically presented below. The hierarchy places the parameters in a context. For example, the parameter 'specific leaf area' belongs to the shoot of a specific genotype. In SimRoot parameters can be a single value, a value drawn from a distribution, or the result of an interpolation table. We have tried to base all our parameters on our own measurements or data from the literature. We have indicated the sources behind the parameters. Note that in many cases, we used more than one source and in some cases we had to convert the measurements using assumptions. A common assumption we made is that the value was equal for all root classes and or for all genotypes.

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.cm^{-2}.day^{-1}]
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} (Rocksprings, PA, weather station data June 2009)
1.2 'dimensions'
1.2.1 'max corner' = 13 0 30 [cm]
1.2.2 'min corner' =-13 -150 -30 [cm]
1.3 'silt-loam soil'
1.3.1 'bulk density' [g.cm^{-3}]=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[cm] x,y pairs :{-200 1.51 -65 1.51 -47 1.4 -30 1.42 -16 1.29 -5 1.24 0 1.24} (M.B. Postma, University Park, unpublished)
1.3.2 'nitrate'
1.3.2.1 'adsorption coefficient' = 0 [umol.cm^{-1}]
1.3.2.2 'buffer power' [-]=f{'depth'} [cm] x,y pairs :{-1000 0.4 1000 0.4}
1.3.2.3 'concentration' [umol.ml^{-1}]=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:{-1000 1.59 -55 1.59 -45 1.67 -35 2.17 -25 3.15 -15 4.02 -5 2.36 0 2.8 0.01 0 100 0}(M.B. Postma, University Park, unpublished)
1.3.2.4 'diffusion coefficient' [cm2.day^{-1}]=f{'depth'} [cm] x,y pairs :{-1000 0.07 -0 0.07 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}]
1.3.2.8 'transverse dispersivity' = 0.5 [cm]
1.3.3 'organic' (Yang & Janssen 2000)
1.3.3.1 ' C/N ratio microbes' = 10 [g.g^{-1}]

1.3.3.2 ' C/N ratio' [g.g^{-1}]=f{'depth'} [cm] x,y pairs :{-10000 13 0 13}
1.3.3.3 'assimilation efficiency microbes' = 1 [-]
1.3.3.4 'carbon content' [g.g^{-1}]=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^{-1}.year^{-1}]=f{'depth'} [cm] x,y pairs :{-1000 0 -25 0 -10 0.037 0 0.037} (Postma, University Park, Unpublished)
1.3.3.5.1 'multiplier' = 0.1 [-]
1.3.3.6 'speed of aging' = 0.46 [-]
1.3.3.7 'time offset' = 30 [day]
1.3.4 'phosphorus' (S. A. Barber 1995; Bhadoria et al. 1991)
1.3.4.1 'adsorption coefficient' = 1333.3 [umol.cm^{-1}]
1.3.4.2 'buffer power' [-]=f{'depth'} [cm] x,y pairs :{-1000 400 1000 400}
1.3.4.3 'concentration' [umol.ml^{-1}]=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^{-1}]=f{'depth'} [cm] x,y pairs :{-1000 0.00019872 1000 0.00019872}
1.3.4.5 'longitudinal dispersivity' = 0 [cm]
1.3.4.6 'r1-r0' = 0.3 [cm]
1.3.4.7 'saturated diffusion coefficient' = 0.00495 [cm2.day^{-1}]
1.3.4.8 'transverse dispersivity' = 0 [cm]
1.3.5 'potassium' (Claassen et al. 1986; S. A. Barber 1995; Dunham & Nye 1976)
1.3.5.1 'adsorption coefficient' = 33.3 [umol.cm^{-1}]
1.3.5.2 'buffer power' [-]=f{'depth'} [cm] x,y pairs :{-1000 10 1000 10}
1.3.5.3 'concentration' [umol.ml^{-1}]=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^{-1}]=f{'depth'} [cm] x,y pairs :{-1000 0.067 1000 0.067}
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}]
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} (M.B. Postma, University Park, Unpublished)
1.3.6.2 'residual water content' [100%]=f{'depth'} [cm] x,y pairs :{-300 0.067 0 0.067} (Hodnett & Tomasella 2002)
1.3.6.3 'saturated conductivity' [cm.day^{-1}]=f{'depth'} [cm] x,y pairs :{-300 10.8 0 10.8} (Luo et al. 2008)
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} (Luo et al. 2008)
1.3.6.5 'van genuchten:alpha' [-.cm^{-1}]=f{'depth'} [cm] x,y pairs :{-300 0.02 0 0.02} (Hodnett & Tomasella 2002)
1.3.6.6 'van genuchten:n' [-]=f{'depth'} [cm] x,y pairs :{-300 1.41 0 1.41} (Hodnett & Tomasella 2002)
1.3.6.7 'volumetric water content in Barber Cushman' = 0.3 [cm3.cm^{-3}]
1.4 'loamy-sand soil'
1.4.1 'water'
1.4.1.1 'initial hydraulic head' [cm]=f{'depth'} [cm] x,y pairs :{-200 -0 -90 -110 -32 -168 -28 -172 -0 -200}

1.4.1.2 'residual water content' [100%]=f{'depth'} [cm] x,y pairs :{-300 0.057 0 0.057}
1.4.1.3 'saturated conductivity' [cm.day^{-1}]=f{'depth'} [cm] x,y pairs :{-200 400 0 400}
1.4.1.4 'saturated water content' [100%]=f{'depth'} [cm] x,y pairs :{-200 0.339 -32 0.339 -28 0.399 0 0.399}
1.4.1.5 'van genuchten:alpha' [-.cm^{-1}]=f{'depth'} [cm] x,y pairs :{-300 0.033 -30 0.033 -28 0.038 0 0.038}
1.4.1.6 'van genuchten:n' [-]=f{'depth'} [cm] x,y pairs :{-200 1.6024 -32 1.6024 -28 1.3757 0 1.3757}
1.4.1.7 'volumetric water content in Barber Cushman' = 0.18 [cm3.cm^{-3}]
1.4.2 see silt-loam soil for other parameters

2 'plant parameters'

2.1 'reference genotype maize' Where references are missing data is based on unpublished data from Jaramillo (2006), Silberbush (2008), Zhang and Postma (2007,2008) and Fita and Postma (2006)

2.1.1 'braceroots'
2.1.1.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan, Zhu, et al. 2003)
2.1.1.2 'branch list'
2.1.1.2.1 'lateral of crown roots'
2.1.1.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.1.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.1.1.2.1.3 'branching spatial offset' = 12 [cm]
2.1.1.2.1.4 'length root tip' = 10.93 [cm]
2.1.1.2.1.5 'number of branches/whorl' = 1 [#]
2.1.1.3 'branching angle' = 140 [degrees]
2.1.1.4 'density' = 0.094 [g.cm^{-3}] (Pahlavanian & Silk 1988)
2.1.1.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.4 8 0.4 15 0.15 24 0.1 100 0.1}
2.1.1.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.1.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0}
2.1.1.8 'length root tip without xylem vessels' = 2 [cm]
2.1.1.9 'longitudinal growth rate multiplier' [cm]=f{'uniform distribution'} minimum=0.7 maximum=1
2.1.1.10 'nitrate'
2.1.1.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.1.1.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.1.1.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.1.1.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.1.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.1.11 'number of xylem poles' = 40 [-]
2.1.1.12 'phosphorus' (S. A. Barber 1995)
2.1.1.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.1.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.1.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.1.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.1.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.1.13 'potassium' (Barber 1995)
2.1.1.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.1.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.1.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.1.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]

2.1.1.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.1.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.1.15 'regular topology' = 4 [-]
2.1.1.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.1.1.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.1.18 'root class id' = 102 [-]
2.1.1.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu, Kaeppler, et al. 2005; Mackay & S. Barber 1985)
2.1.1.20 'root hair diameter' = 0.0005 [cm]
2.1.1.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.1.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.1.2 'braceroots2'
2.1.2.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.2.2 'branch list'
2.1.2.2.1 'lateral of crown roots'
2.1.2.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.2.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.4
2.1.2.2.1.3 'branching spatial offset' = 15 [cm]
2.1.2.2.1.4 'length root tip' = 10.93 [cm]
2.1.2.2.1.5 'number of branches/whorl' = 1 [#]
2.1.2.3 'branching angle' = 130 [degrees]
2.1.2.4 'density' = 0.094 [g.cm^{-3}]
2.1.2.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.5 9 0.5 16 0.2 24 0.1 100 0.1}
2.1.2.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.2.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0}
2.1.2.8 'length root tip without xylem vessels' = 2 [cm]
2.1.2.9 'longitudinal growth rate multiplier' [cm]=f{'uniform distribution'} minimum=0.7 maximum=1
2.1.2.10 'nitrate'
2.1.2.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.1.2.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.1.2.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.1.2.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.2.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.2.11 'number of xylem poles' = 48 [-]
2.1.2.12 'phosphorus' (Barber 1995)
2.1.2.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.2.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.2.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.2.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.2.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.2.13 'potassium' (Barber 1995)
2.1.2.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.2.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]

2.1.2.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.2.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.2.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.2.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.2.15 'regular topology' = 3 [-]
2.1.2.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.1.2.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.2.18 'root class id' = 102 [-]
2.1.2.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.2.20 'root hair diameter' = 0.0005 [cm]
2.1.2.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.2.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.1.3 'finelateral'
2.1.3.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.3.2 'branch list'
2.1.3.2.1 'finelateral2'
2.1.3.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.3.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.4 maximum=0.6
2.1.3.2.1.3 'length root tip' = 1.5 [cm]
2.1.3.3 'branching angle' = 62.83 [degrees]
2.1.3.4 'density' = 0.094 [g.cm^{-3}]
2.1.3.5 'diameter' = 0.025 [cm]
2.1.3.6 'gravitropism.v2' = 0 0 0 [cm]
2.1.3.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.35 6 0 1000 0}
2.1.3.8 'length root tip without xylem vessels' = 2 [cm]
2.1.3.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.1.3.10 'nitrate'
2.1.3.10.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.1.3.10.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.1.3.10.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.1.3.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.3.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.3.11 'number of xylem poles' = 4 [-]
2.1.3.12 'phosphorus' (Barber 1995)
2.1.3.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.3.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.3.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.3.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.3.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.3.13 'potassium' (Barber 1995)
2.1.3.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.3.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]

2.1.3.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.3.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.3.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986) (Silk et al. 1986)
2.1.3.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.3.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 1e-06}
2.1.3.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.3.17 'root class id' = 98 [-]
2.1.3.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.3.19 'root hair diameter' = 0.0005 [cm]
2.1.3.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.3.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.1.4 'finelateral2'
2.1.4.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.4.2 'branch list'
2.1.4.3 'branching angle' = 62.83 [degrees]
2.1.4.4 'density' = 0.094 [g.cm^{-3}]
2.1.4.5 'diameter' = 0.015 [cm]
2.1.4.6 'gravitropism.v2' = 0 0 0 [cm]
2.1.4.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.001 1 0.28 4 0 1000 0}
2.1.4.8 'length root tip without xylem vessels' = 2 [cm]
2.1.4.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.1.4.10 'nitrate'
2.1.4.10.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.1.4.10.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.1.4.10.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.1.4.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.4.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.4.11 'number of xylem poles' = 4 [-]
2.1.4.12 'phosphorus' (Barber 1995)
2.1.4.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.4.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.4.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.4.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.4.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.4.13 'potassium' (Barber 1995)
2.1.4.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.4.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.4.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.4.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.4.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.4.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)

2.1.4.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 1e-06}
2.1.4.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.4.17 'root class id' = 98 [-]
2.1.4.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.4.19 'root hair diameter' = 0.0005 [cm]
2.1.4.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.4.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.1.5 'mesocotyl'
2.1.5.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.1.5.2 'branch list'
2.1.5.2.1 'braceroots'
2.1.5.2.1.1 'allometric scaling' = 1 [-]
2.1.5.2.1.2 'branching spatial offset' = 4 [cm]
2.1.5.2.1.3 'branching time offset' = 25 [day]
2.1.5.2.1.4 'number of branches/whorl' = 14 [#]
2.1.5.2.2 'braceroots2'
2.1.5.2.2.1 'allometric scaling' = 1 [-]
2.1.5.2.2.2 'branching delay' = 14 [day]
2.1.5.2.2.3 'branching frequency' = 5 [cm]
2.1.5.2.2.4 'branching spatial offset' = 7 [cm]
2.1.5.2.2.5 'branching time offset' = 36 [day]
2.1.5.2.2.6 'number of branches/whorl' = 20 [#]
2.1.5.2.3 'nodalroots'
2.1.5.2.3.1 'branching spatial offset' = 1.5 [cm]
2.1.5.2.3.2 'branching time offset' = 9 [day]
2.1.5.2.3.3 'number of branches/whorl' = 3 [#]
2.1.5.2.4 'nodalroots2'
2.1.5.2.4.1 'allometric scaling' = 1 [-]
2.1.5.2.4.2 'branching spatial offset' = 1.9 [cm]
2.1.5.2.4.3 'branching time offset' = 16 [day]
2.1.5.2.4.4 'number of branches/whorl' = 4 [#]
2.1.5.2.5 'nodalroots3'
2.1.5.2.5.1 'allometric scaling' = 1 [-]
2.1.5.2.5.2 'branching spatial offset' = 2.1 [cm]
2.1.5.2.5.3 'branching time offset' = 20 [day]
2.1.5.2.5.4 'number of branches/whorl' = 5 [#]
2.1.5.2.6 'nodalroots4'
2.1.5.2.6.1 'allometric scaling' = 1 [-]
2.1.5.2.6.2 'branching spatial offset' = 2.3 [cm]
2.1.5.2.6.3 'branching time offset' = 23 [day]
2.1.5.2.6.4 'number of branches/whorl' = 6 [#]
2.1.5.3 'density' = 0.094 [g.cm^{-3}]
2.1.5.4 'diameter' = 0.15 [cm]
2.1.5.5 'gravitropism' =-1 [-]
2.1.5.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=0.5 maximum=1

2.1.5.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 1 1 2 2 2 3 2 5 0 1000 0}
2.1.5.8 'length root tip without xylem vessels' = 2 [cm]
2.1.5.9 'nitrate'
2.1.5.9.1 ' Cmin' = 0 [umol.ml^{-1}]
2.1.5.9.2 ' Imax' = 0 [umol.cm^{-2}.day^{-1}]
2.1.5.9.3 ' Km' = 1 [umol.ml^{-1}]
2.1.5.9.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.5.9.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.5.10 'number of xylem poles' = 61 [-]
2.1.5.11 'phosphorus' (Barber 1995)
2.1.5.11.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.5.11.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.5.11.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.5.11.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.5.11.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.5.12 'potassium' (Barber 1995)
2.1.5.12.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.5.12.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.5.12.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.5.12.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.5.12.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.5.13 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.5.14 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.1.5.15 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.5.16 'root class id' = 97 [-]
2.1.5.17 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 0 2000 0}
2.1.5.18 'root hair diameter' = 0.0005 [cm]
2.1.5.19 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.5.20 'soil impedence' = 0.3 [-]
2.1.5.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.3 maximum=0.3
2.1.5.22 'top boundary' = 0 [-]
2.1.6 'lateral'
2.1.6.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.6.2 'bottom boundary' = 1 [-]
2.1.6.3 'branch list'
2.1.6.3.1 'finelateral'
2.1.6.3.1.1 'allow branches to form above ground' = 0 [-]
2.1.6.3.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.15 maximum=0.35
2.1.6.3.1.3 'length root tip' = 4 [cm]
2.1.6.4 'branching angle' = 90 [degrees]
2.1.6.5 'density' = 0.094 [g.cm^{-3}]
2.1.6.6 'diameter' = 0.04 [cm]
2.1.6.7 'gravitropism.v2' = 0 0 0 [cm]
2.1.6.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.2 3 0.4 7 1 11 0 1000 0}

2.1.6.9 'length root tip without xylem vessels' = 2 [cm]
2.1.6.10 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.1 maximum=2 mean=0.7 stdev=0.3
2.1.6.11 'nitrate'
2.1.6.11.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.1.6.11.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.1.6.11.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.1.6.11.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.6.11.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.6.12 'number of xylem poles' = 4 [-]
2.1.6.13 'phosphorus' (Barber 1995)
2.1.6.13.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.6.13.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.6.13.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.6.13.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.6.13.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.6.14 'potassium' (Barber 1995)
2.1.6.14.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.6.14.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.6.14.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.6.14.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.6.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.6.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.6.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 3e-06}
2.1.6.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.6.18 'root class id' = 98 [-]
2.1.6.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.6.20 'root hair diameter' = 0.0005 [cm]
2.1.6.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.6.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.1.6.23 'top boundary' = 1 [-]
2.1.7 'lateral of crown roots'
2.1.7.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.7.2 'branch list'
2.1.7.2.1 'lateral'
2.1.7.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.7.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.25 maximum=0.35
2.1.7.2.1.3 'length root tip' = 5 [cm]
2.1.7.3 'branching angle' = 90 [degrees]
2.1.7.4 'density' = 0.094 [g.cm^{-3}]
2.1.7.5 'diameter' = 0.07 [cm]
2.1.7.6 'gravitropism' = 0 [-]

2.1.7.7 'gravitropism.v2' = 0 0 0 [cm]
2.1.7.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.1 1 0.5 3 1.2 12 1.2 18 0 1000 0}
2.1.7.9 'length root tip without xylem vessels' = 2 [cm]
2.1.7.10 'longitudinal growth rate multiplier' [cm]=f{' normal distribution'} minimum=0.1 maximum=1 mean=0.4 stdev=0.3
2.1.7.11 'nitrate'
2.1.7.11.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.1.7.11.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.1.7.11.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.1.7.11.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.7.11.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.7.12 'number of xylem poles' = 4 [-]
2.1.7.13 'phosphorus' (Barber 1995)
2.1.7.13.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.7.13.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.7.13.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.7.13.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.7.13.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.7.14 'potassium' (Barber 1995)
2.1.7.14.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.7.14.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.7.14.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.7.14.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.7.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.7.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.7.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 4e-06}
2.1.7.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.7.18 'root class id' = 98 [-]
2.1.7.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.7.20 'root hair diameter' = 0.0005 [cm]
2.1.7.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.7.22 'soil impedence' = 0.05 [-]
2.1.7.23 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.1.8 'nodalroots'
2.1.8.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.8.2 'branch list'
2.1.8.2.1 'lateral'
2.1.8.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.8.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.1.8.2.1.3 'length root tip' = 10.93 [cm]
2.1.8.3 'branching angle' = 160 [degrees]
2.1.8.4 'density' = 0.094 [g.cm^{-3}]
2.1.8.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.12 10 0.09 100 0.09}

2.1.8.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.8.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.1.8.8 'length root tip without xylem vessels' = 2 [cm]
2.1.8.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.8.10 'nitrate'
2.1.8.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.1.8.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.1.8.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.1.8.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.8.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.8.11 'number of xylem poles' = 10 [-]
2.1.8.12 'phosphorus' (Barber 1995)
2.1.8.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.8.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.8.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.8.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.8.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.8.13 'potassium' (Barber 1995)
2.1.8.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.8.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.8.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.8.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.8.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.8.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.8.15 'regular topology' = 3 [-]
2.1.8.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.1.8.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.8.18 'root class id' = 101 [-]
2.1.8.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.8.20 'root hair diameter' = 0.0005 [cm]
2.1.8.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.8.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.1.8.23 'topology offset' = 0 [-]
2.1.9 'nodalroots2'
2.1.9.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.9.2 'branch list'
2.1.9.2.1 'lateral'
2.1.9.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.9.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.1.9.2.1.3 'length root tip' = 10.93 [cm]
2.1.9.3 'branching angle' = 150 [degrees]
2.1.9.4 'density' = 0.094 [g.cm^{-3}]

2.1.9.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.14 10 0.09 100 0.09}
2.1.9.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.9.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.1.9.8 'length root tip without xylem vessels' = 2 [cm]
2.1.9.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.9.10 'nitrate'
2.1.9.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.1.9.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.1.9.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.1.9.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.9.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.9.11 'number of xylem poles' = 18 [-]
2.1.9.12 'phosphorus' (Barber 1995)
2.1.9.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.9.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.9.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.9.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.9.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.9.13 'potassium' (Barber 1995)
2.1.9.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.9.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.9.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.9.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.9.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.9.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.9.15 'regular topology' = 0 [-]
2.1.9.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.1.9.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.9.18 'root class id' = 101 [-]
2.1.9.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.9.20 'root hair diameter' = 0.0005 [cm]
2.1.9.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.9.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.1.9.23 'topology offset' = 0 [-]
2.1.10 'nodalroots3'
2.1.10.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.10.2 'branch list'
2.1.10.2.1 'lateral'
2.1.10.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.10.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.1.10.2.1.3 'length root tip' = 10.93 [cm]

2.1.10.3 'branching angle' = 140 [degrees]
2.1.10.4 'density' = 0.094 [g.cm^{-3}]
2.1.10.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.16 10 0.1 100 0.1}
2.1.10.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.1.10.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.1.10.8 'length root tip without xylem vessels' = 2 [cm]
2.1.10.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.10.10 'nitrate'
2.1.10.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.1.10.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.1.10.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.1.10.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.10.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.10.11 'number of xylem poles' = 24 [-]
2.1.10.12 'phosphorus' (Barber 1995)
2.1.10.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.10.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.10.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.10.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.10.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.1.10.13 'potassium' (Barber 1995)
2.1.10.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.10.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.10.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.10.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.10.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.10.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.10.15 'regular topology' = 0 [-]
2.1.10.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.1.10.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.10.18 'root class id' = 101 [-]
2.1.10.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.10.20 'root hair diameter' = 0.0005 [cm]
2.1.10.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.10.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.1.10.23 'topology offset' = 0 [-]
2.1.11 'nodalroots4'
2.1.11.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.11.2 'branch list'
2.1.11.2.1 'lateral'
2.1.11.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.11.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1

maximum=0.3

2.1.11.2.1.3 'length root tip' = 10.93 [cm]

2.1.11.3 'branching angle' = 130 [degrees]

2.1.11.4 'density' = 0.094 [g.cm^{-3}]

2.1.11.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.2 10 0.11 100 0.11}

2.1.11.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005

2.1.11.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}

2.1.11.8 'length root tip without xylem vessels' = 2 [cm]

2.1.11.9 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1

2.1.11.10 'nitrate'

2.1.11.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]

2.1.11.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}

2.1.11.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}

2.1.11.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]

2.1.11.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]

2.1.11.11 'number of xylem poles' = 32 [-]

2.1.11.12 'phosphorus' (Barber 1995)

2.1.11.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]

2.1.11.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]

2.1.11.12.3 ' Km' = 0.00545 [umol.ml^{-1}]

2.1.11.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]

2.1.11.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]

2.1.11.13 'potassium' (Barber 1995)

2.1.11.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]

2.1.11.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]

2.1.11.13.3 ' Km' = 0.014 [umol.ml^{-1}]

2.1.11.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]

2.1.11.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)

2.1.11.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)

2.1.11.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)

2.1.11.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)

2.1.11.17 'root class id' = 101 [-]

2.1.11.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)

2.1.11.19 'root hair diameter' = 0.0005 [cm]

2.1.11.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)

2.1.11.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02

2.1.12 'primary root'

2.1.12.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)

2.1.12.2 'branch list'

2.1.12.2.1 'lateral'

2.1.12.2.1.1 'allow branches to form above ground' = 0 [-]

2.1.12.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.25

maximum=0.45
2.1.12.2.1.3 'length root tip' = 10.93 [cm]
2.1.12.2.2 'seminal'
2.1.12.2.2.1 'allow branches to form above ground' = 0 [-]
2.1.12.2.2.2 'branching frequency' = 1 [cm]
2.1.12.2.2.3 'branching time offset' = 1 [day]
2.1.12.2.2.4 'max number of branches' = 5 [#]
2.1.12.2.2.5 'number of branches/whorl' = 5 [#]
2.1.12.3 'branching angle' = 0 [degrees]
2.1.12.4 'density' = 0.094 [$g.cm^{-3}$]
2.1.12.5 'diameter' = 0.065 [cm]
2.1.12.6 'gravitropism' = 0.01 [-]
2.1.12.7 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.015 maximum=-0.005
2.1.12.8 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 4.5 28 4.5 38 0 1000 0}
2.1.12.9 'length root tip without xylem vessels' = 2 [cm]
2.1.12.10 'nitrate'
2.1.12.10.1 ' Cmin' = 0.001 [$umol.ml^{-1}$]
2.1.12.10.2 ' Imax' [$umol.cm^{-2}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 2.3 2 1.92 40 1.92}
2.1.12.10.3 ' Km [$umol.ml^{-1}$]=f{'age'} [day] x,y pairs :{0 0.0105 2 0.0161 40 0.0161}
2.1.12.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.1.12.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.1.12.11 'number of xylem poles' = 8 [-]
2.1.12.12 'phosphorus' (Barber 1995)
2.1.12.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.1.12.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.1.12.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.1.12.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.1.12.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.1.12.13 'potassium' (Barber 1995)
2.1.12.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.1.12.13.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.1.12.13.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.1.12.13.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.1.12.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.12.14 'radial hydraulic conductivity' [$cm.day^{-1}.hPa^{-1}$]=f{'time since planting'} [day] x,y pairs :{0 0 1 0.000216 10 0.000216 20 0.000216 30 0.000116 40 5e-05 60 0}
2.1.12.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.12.16 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.1.12.17 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.12.18 'root class id' = 100 [-]
2.1.12.19 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.12.20 'root hair diameter' = 0.0005 [cm]
2.1.12.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.12.22 'soil impedence' = 0.05 [-]

2.1.12.23 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.1.13 'resources'
2.1.13.1 'carbon to dry weight ratio' = 0.45 [100%]
2.1.13.2 '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}
2.1.13.3 '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}
2.1.13.4 'carbon cost of nitrate uptake' = 1.392e-05 [g.umol^{-1}]
2.1.13.5 'max carbon allocation2 shoot' = 0.82 [100%]
2.1.13.6 'nitrate'
2.1.13.6.1 'initial nutrient uptake' = 285 [umol]
2.1.13.7 'phosphorus' (Barber 1995)
2.1.13.7.1 'initial nutrient uptake' = 20 [umol]
2.1.13.8 'potassium' (Barber 1995)
2.1.13.8.1 'initial nutrient uptake' = 27 [umol]
2.1.13.9 'reserve allocation rate' [%.day^{-1}]=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}
2.1.13.10 'seed size' = 0.15 [g]
2.1.14 'seminal'
2.1.14.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.1 10 0.25 20 0.393 1000 0.393} (Fan et al. 2003)
2.1.14.2 'branch list'
2.1.14.2.1 'lateral'
2.1.14.2.1.1 'allow branches to form above ground' = 0 [-]
2.1.14.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.05 maximum=0.25
2.1.14.2.1.3 'length root tip' = 10.93 [cm]
2.1.14.3 'branching angle' = 90 [degrees]
2.1.14.4 'density' = 0.094 [g.cm^{-3}]
2.1.14.5 'diameter' = 0.085 [cm]
2.1.14.6 'gravitropism' = 0.004 [-]
2.1.14.7 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.035 maximum=-0.025
2.1.14.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.5 2 4.5 28 4.5 38 0 100 0}
2.1.14.9 'length root tip without xylem vessels' = 2 [cm]
2.1.14.10 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.1.14.11 'nitrate'
2.1.14.11.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.1.14.11.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 2.3 2 1.92 40 1.92}
2.1.14.11.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0105 2 0.0161 40 0.0161}
2.1.14.11.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.1.14.11.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.1.14.12 'number of xylem poles' = 6 [-]
2.1.14.13 'phosphorus' (Barber 1995)
2.1.14.13.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.1.14.13.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.1.14.13.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.1.14.13.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.14.13.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]

2.1.14.14 'potassium' (Barber 1995)
2.1.14.14.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.1.14.14.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.1.14.14.3 ' Km' = 0.014 [umol.ml^{-1}]
2.1.14.14.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.14.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.1.14.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.1.14.16 'regular topology' = 1 [-]
2.1.14.17 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.1.14.18 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.1.14.19 'root class id' = 99 [-]
2.1.14.20 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.14.21 'root hair diameter' = 0.0005 [cm]
2.1.14.22 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.1.14.23 'soil impedence' = 0.02 [-]
2.1.14.24 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.1.15 'shoot'
2.1.15.1 'area per plant' = 1600 [cm2]
2.1.15.2 'extinction coefficient' = 0.85 [-]
2.1.15.3 'leaf area expantion rate' [cm2.day^{-1}]=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} (Zhang and Postma, University Park, unpublished)
2.1.15.4 'light use efficiency' = 3.8e-07 [g.umol-1] (Stirling et al. 1994; Postma, University Park, unpublished)
2.1.15.5 'nitrate'
2.1.15.5.1 'leaf minimal nutrient concentration' [umol.g^{-1}]=f{'time'} [day] x,y pairs :{0 1200 80 800}
2.1.15.5.2 'leaf optimal nutrient concentration' [umol.g^{-1}]=f{'time'} [day] x,y pairs :{0 2500 80 1500} (Zhang and Postma, University Park, Unpublished; Alexandrova & Donov 2003; Chevalier & Schrader 1977)
2.1.15.5.3 'stem minimal nutrient concentration' = 400 [umol.g^{-1}]
2.1.15.5.4 'stem optimal nutrient concentration' = 800 [umol.g^{-1}]
2.1.15.6 'phosphorus'
2.1.15.6.1 'leaf minimal nutrient concentration' = 35 [umol.g^{-1}]
2.1.15.6.2 'leaf optimal nutrient concentration' = 70 [umol.g-1] (Zhang and Postma, University

Park, unpublished)
2.1.15.6.3 'stem minimal nutrient concentration' = 15 [umol.g^{-1}]
2.1.15.6.4 'stem optimal nutrient concentration' = 30 [umol.g^{-1}]
2.1.15.7 'potassium'
2.1.15.7.1 'leaf minimal nutrient concentration' = 273 [umol.g^{-1}]
2.1.15.7.2 'leaf optimal nutrient concentration' = 508 [umol.g-1] (Leigh & Jones 1984)
2.1.15.7.3 'stem minimal nutrient concentration' = 117 [umol.g^{-1}]
2.1.15.7.4 'stem optimal nutrient concentration' = 250 [umol.g^{-1}]
2.1.15.8 'relative potential transpiration' = 100 [cm3.g-1] (Baldocchi 1994)
2.1.15.9 'relative respiration rate leafs' = 0.04 [g.g-1.day-1] (Postma, University Park, Unpublished)
2.1.15.10 'relative respiration rate stems' = 0.02 [g.g^{-1}.day^{-1}]
2.1.15.11 'specific leaf area' [g.cm^{-2}]=f{'time'} [day] x,y pairs :{0 0.0015 24 0.0026 50 0.0032 100 0.0032} (van Heemst 1988; Jacob & Lawlor 1991; Jaramillo, University Park, unpublished)
2.1.16 'stress impact factors'
2.1.16.1 'impact on:leaf area expantion rate'
2.1.16.1.1 'impact by:nitrate' [-]=f{'nitrate stress factor'} [-] x,y pairs :{0 0 0.3 0.1 1 1} (Sinclair & Horie 1989)
2.1.16.1.2 'impact by:phosphorus' [-]=f{'phosphorus stress factor'} [-] x,y pairs :{0 0 1 1} (Lynch et al. 1991; Usuda & Shimogawara 1991) (Lynch et al. 1991; Usuda & Shimogawara 1991)
2.1.16.1.3 'impact by:potassium' [-]=f{'potassium stress factor'} [-] x,y pairs :{0 0 0.2 0.5 1 1}
2.1.16.2 'impact on:photosynthesis'
2.1.16.2.1 'impact by:nitrate' [-]=f{'nitrate stress factor'} [-] x,y pairs :{0 0 0.4 0.5 1 1} (Sinclair & Horie 1989)
2.1.16.2.2 'impact by:phosphorus' [-]=f{'phosphorus stress factor'} [-] x,y pairs :{0 0.5 0.5 1 1 1} (Lynch et al. 1991; Usuda & Shimogawara 1991)
2.1.16.2.3 'impact by:potassium' [-]=f{'potassium stress factor'} [-] x,y pairs :{0 0 1 1}
2.2 '36H56'
2.2.1 'braceroots'
2.2.1.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.11 1000 0.11} (Burton 2010)
2.2.1.2 'branch list'
2.2.1.2.1 'lateral of crown roots'
2.2.1.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.1.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.2.1.2.1.3 'branching spatial offset' = 12 [cm]
2.2.1.2.1.4 'length root tip' = 10.93 [cm]
2.2.1.2.1.5 'number of branches/whorl' = 1 [#]
2.2.1.3 'branching angle' = 140 [degrees]
2.2.1.4 'density' = 0.094 [g.cm^{-3}]
2.2.1.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.223 7 0.145 100 0.135} (Burton, University Park, Unpublished)
2.2.1.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.2.1.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0}
2.2.1.8 'length root tip without xylem vessels' = 2 [cm]
2.2.1.9 'longitudinal growth rate multiplier' [cm]=f{'uniform distribution'} minimum=0.7 maximum=1
2.2.1.10 'nitrate'

2.2.1.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.2.1.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.2.1.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.2.1.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.2.1.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.2.1.11 'number of xylem poles' = 40 [-]
2.2.1.12 'phosphorus' (Barber 1995)
2.2.1.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.2.1.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.2.1.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.2.1.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.2.1.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.2.1.13 'potassium' (Barber 1995)
2.2.1.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.2.1.13.2
2.2.1.13.3 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.2.1.13.4 ' Km' = 0.014 [umol.ml^{-1}]
2.2.1.13.5 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.2.1.13.6 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.1.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.2.1.15 'regular topology' = 4 [-]
2.2.1.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.2.1.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.1.18 'root class id' = 102 [-]
2.2.1.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.1.20 'root hair diameter' = 0.0005 [cm]
2.2.1.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.1.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.2.2 'braceroots2'
2.2.2.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.11 1000 0.11} (Burton 2010)
2.2.2.2 'branch list'
2.2.2.2.1 'lateral of crown roots'
2.2.2.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.2.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.4
2.2.2.2.1.3 'branching spatial offset' = 15 [cm]
2.2.2.2.1.4 'length root tip' = 10.93 [cm]
2.2.2.2.1.5 'number of branches/whorl' = 1 [#]
2.2.2.3 'branching angle' = 130 [degrees]
2.2.2.4 'density' = 0.094 [g.cm^{-3}]
2.2.2.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.253 7 0.175 100 0.175} (Burton, University Park, Unpublished)
2.2.2.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.2.2.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0}

2.2.2.8 'length root tip without xylem vessels' = 2 [cm]
2.2.2.9 'longitudinal growth rate multiplier' [cm]=f{'uniform distribution'} minimum=0.7 maximum=1
2.2.2.10 'nitrate'
2.2.2.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.2.2.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.2.2.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.2.2.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.2.2.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.2.2.11 'number of xylem poles' = 48 [-]
2.2.2.12 'phosphorus' (Barber 1995)
2.2.2.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.2.2.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.2.2.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.2.2.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.2.2.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.2.2.13 'potassium' (Barber 1995)
2.2.2.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.2.2.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.2.2.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.2.2.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.2.2.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.2.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.2.2.15 'regular topology' = 3 [-]
2.2.2.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.2.2.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.2.18 'root class id' = 102 [-]
2.2.2.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.2.20 'root hair diameter' = 0.0005 [cm]
2.2.2.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.2.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.2.3 'finelateral'
2.2.3.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.2.3.2 'branch list'
2.2.3.2.1 'finelateral2'
2.2.3.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.3.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.4 maximum=0.6
2.2.3.2.1.3 'length root tip' = 1.5 [cm]
2.2.3.3 'branching angle' = 62.83 [degrees]
2.2.3.4 'density' = 0.094 [g.cm^{-3}]
2.2.3.5 'diameter' = 0.025 [cm]
2.2.3.6 'gravitropism.v2' = 0 0 0 [cm]
2.2.3.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.35 6 0 1000 0}
2.2.3.8 'length root tip without xylem vessels' = 2 [cm]

2.2.3.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.2.3.10 'nitrate'
2.2.3.10.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.2.3.10.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.2.3.10.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.2.3.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.2.3.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.2.3.11 'number of xylem poles' = 4 [-]
2.2.3.12 'phosphorus' (Barber 1995)
2.2.3.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.2.3.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.2.3.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.2.3.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.2.3.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.2.3.13 'potassium' (Barber 1995)
2.2.3.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]]
2.2.3.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.2.3.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.2.3.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.2.3.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.3.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1 1 1}
2.2.3.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 1e-06}
2.2.3.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.3.17 'root class id' = 98 [-]
2.2.3.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.3.19 'root hair diameter' = 0.0005 [cm]
2.2.3.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.3.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.2.4 'finelateral2'
2.2.4.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.2.4.2 'bottom boundary' = 1 [-]
2.2.4.3 'branch list'
2.2.4.4 'branching angle' = 62.83 [degrees]
2.2.4.5 'density' = 0.094 [g.cm^{-3}]
2.2.4.6 'diameter' = 0.015 [cm]
2.2.4.7 'gravitropism.v2' = 0 0 0 [cm]
2.2.4.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.001 1 0.28 4 0 1000 0}
2.2.4.9 'length root tip without xylem vessels' = 2 [cm]
2.2.4.10 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.2.4.11 'nitrate'
2.2.4.11.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.2.4.11.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]

2.2.4.11.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.2.4.11.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.2.4.11.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.2.4.12 'number of xylem poles' = 4 [-]
2.2.4.13 'phosphorus' (Barber 1995)
2.2.4.13.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.2.4.13.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.2.4.13.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.2.4.13.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.2.4.13.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.2.4.14 'potassium' (Barber 1995)
2.2.4.14.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.2.4.14.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.2.4.14.3 ' Km' = 0.014 [umol.ml^{-1}]
2.2.4.14.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.2.4.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.4.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1 1 1}
2.2.4.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 1e-06}
2.2.4.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.4.18 'root class id' = 98 [-]
2.2.4.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.4.20 'root hair diameter' = 0.0005 [cm]
2.2.4.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.4.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.2.5 'mesocotyl'
2.2.5.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.2.5.2 'branch list'
2.2.5.2.1 'braceroots'
2.2.5.2.1.1 'allometric scaling' = 1 [-]
2.2.5.2.1.2 'branching spatial offset' = 4 [cm]
2.2.5.2.1.3 'branching time offset' = 25 [day]
2.2.5.2.1.4 'number of branches/whorl' = 14 [#]
2.2.5.2.2 'braceroots2'
2.2.5.2.2.1 'allometric scaling' = 1 [-]
2.2.5.2.2.2 'branching delay' = 14 [day]
2.2.5.2.2.3 'branching frequency' = 5 [cm]
2.2.5.2.2.4 'branching spatial offset' = 7 [cm]
2.2.5.2.2.5 'branching time offset' = 36 [day]
2.2.5.2.2.6 'number of branches/whorl' = 20 [#]
2.2.5.2.3 'nodalroots'
2.2.5.2.3.1 'branching spatial offset' = 1.5 [cm]
2.2.5.2.3.2 'branching time offset' = 9 [day]
2.2.5.2.3.3 'number of branches/whorl' = 3 [#]
2.2.5.2.4 'nodalroots2'

2.2.5.2.4.1 'allometric scaling' = 1 [-]
2.2.5.2.4.2 'branching spatial offset' = 1.9 [cm]
2.2.5.2.4.3 'branching time offset' = 16 [day]
2.2.5.2.4.4 'number of branches/whorl' = 4 [#]
2.2.5.2.5 'nodalroots3'
2.2.5.2.5.1 'allometric scaling' = 1 [-]
2.2.5.2.5.2 'branching spatial offset' = 2.1 [cm]
2.2.5.2.5.3 'branching time offset' = 20 [day]
2.2.5.2.5.4 'number of branches/whorl' = 5 [#]
2.2.5.2.6 'nodalroots4'
2.2.5.2.6.1 'allometric scaling' = 1 [-]
2.2.5.2.6.2 'branching spatial offset' = 2.3 [cm]
2.2.5.2.6.3 'branching time offset' = 23 [day]
2.2.5.2.6.4 'number of branches/whorl' = 6 [#]
2.2.5.3 'density' = 0.094 [$g.cm^{-3}$]
2.2.5.4 'diameter' = 0.15 [cm]
2.2.5.5 'gravitropism' =-1 [-]
2.2.5.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=0.5 maximum=1
2.2.5.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 1 1 2 2 2 3 2 5 0 1000 0}
2.2.5.8 'length root tip without xylem vessels' = 2 [cm]
2.2.5.9 'nitrate'
2.2.5.9.1 ' Cmin' = 0 [$umol.ml^{-1}$]
2.2.5.9.2 ' Imax' = 0 [$umol.cm^{-2}.day^{-1}$]
2.2.5.9.3 ' Km' = 1 [$umol.ml^{-1}$]
2.2.5.9.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.2.5.9.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.2.5.10 'number of xylem poles' = 61 [-]
2.2.5.11 'phosphorus' (Barber 1995)
2.2.5.11.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.2.5.11.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.2.5.11.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.2.5.11.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.2.5.11.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.2.5.12 'potassium' (Barber 1995)
2.2.5.12.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.2.5.12.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.2.5.12.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.2.5.12.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.2.5.12.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.5.13 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.2.5.14 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.2.5.15 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.5.16 'root class id' = 97 [-]
2.2.5.17 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 0 2000 0}
2.2.5.18 'root hair diameter' = 0.0005 [cm]
2.2.5.19 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)

2.2.5.20 'soil impedence' = 0.3 [-]
2.2.5.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.3 maximum=0.3
2.2.5.22 'top boundary' = 0 [-]
2.2.6 'lateral'
2.2.6.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.2.6.2 'branch list'
2.2.6.2.1 'finelateral'
2.2.6.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.6.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.15 maximum=0.35
2.2.6.2.1.3 'length root tip' = 4 [cm]
2.2.6.3 'branching angle' = 90 [degrees]
2.2.6.4 'density' = 0.094 [$g.cm^{-3}$]
2.2.6.5 'diameter' = 0.04 [cm]
2.2.6.6 'gravitropism.v2' = 0 0 0 [cm]
2.2.6.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.01 1 0.2 3 0.7 5 1 11 0 1000 0}
2.2.6.8 'length root tip without xylem vessels' = 2 [cm]
2.2.6.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.1 maximum=2 mean=0.7 stdev=0.3
2.2.6.10 'nitrate'
2.2.6.10.1 ' Cmin' = 0.0017 [$umol.ml^{-1}$]
2.2.6.10.2 ' Imax' = 1.27 [$umol.cm^{-2}.day^{-1}$]
2.2.6.10.3 ' Km' = 0.0027 [$umol.ml^{-1}$]
2.2.6.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.2.6.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.2.6.11 'number of xylem poles' = 4 [-]
2.2.6.12 'phosphorus' (Barber 1995)
2.2.6.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.2.6.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.2.6.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.2.6.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.2.6.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.2.6.13 'potassium' (Barber 1995)
2.2.6.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.2.6.13.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.2.6.13.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.2.6.13.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.2.6.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.6.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1 1 1}
2.2.6.15 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 3e-06}
2.2.6.16 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.6.17 'root class id' = 98 [-]
2.2.6.18 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.6.19 'root hair diameter' = 0.0005 [cm]
2.2.6.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20

(Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.6.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.2.7 'lateral of crown roots'
2.2.7.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.2.7.2 'branch list'
2.2.7.2.1 'lateral'
2.2.7.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.7.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.25 maximum=0.35
2.2.7.2.1.3 'length root tip' = 5 [cm]
2.2.7.3 'branching angle' = 90 [degrees]
2.2.7.4 'density' = 0.094 [$g.cm^{-3}$]
2.2.7.5 'diameter' = 0.07 [cm]
2.2.7.6 'gravitropism' = 0 [-]
2.2.7.7 'gravitropism.v2' = 0 0 0 [cm]
2.2.7.8 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.1 1 0.5 3 1.2 12 1.2 18 0 1000 0}
2.2.7.9 'length root tip without xylem vessels' = 2 [cm]
2.2.7.10 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.1 maximum=1 mean=0.4 stdev=0.3
2.2.7.11 'nitrate'
2.2.7.11.1 ' Cmin' = 0.0017 [$umol.ml^{-1}$]
2.2.7.11.2 ' Imax' = 1.27 [$umol.cm^{-2}.day^{-1}$]
2.2.7.11.3 ' Km' = 0.0027 [$umol.ml^{-1}$]
2.2.7.11.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.2.7.11.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.2.7.12 'number of xylem poles' = 4 [-]
2.2.7.13 'phosphorus' (Barber 1995)
2.2.7.13.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.2.7.13.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.2.7.13.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.2.7.13.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.2.7.13.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.2.7.14 'potassium' (Barber 1995)
2.2.7.14.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.2.7.14.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.2.7.14.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.2.7.14.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.2.7.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.7.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1 1 1}
2.2.7.16 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 4e-06}
2.2.7.17 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.7.18 'root class id' = 98 [-]
2.2.7.19 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.7.20 'root hair diameter' = 0.0005 [cm]
2.2.7.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20

(Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.7.22 'soil impedence' = 0.05 [-]
2.2.7.23 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.2.8 'nodalroots'
2.2.8.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.08 10 0.16 1000 0.16} (Burton 2010)
2.2.8.2 'branch list'
2.2.8.2.1 'lateral'
2.2.8.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.8.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.2.8.2.1.3 'length root tip' = 10.93 [cm]
2.2.8.3 'branching angle' = 160 [degrees]
2.2.8.4 'density' = 0.094 [$g.cm^{-3}$]
2.2.8.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.085 7 0.094 100 0.085} (Burton, University Park, Unpublished)
2.2.8.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.2.8.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.2.8.8 'length root tip without xylem vessels' = 2 [cm]
2.2.8.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.2.8.10 'nitrate'
2.2.8.10.1 ' Cmin' = 0.001 [$umol.ml^{-1}$]
2.2.8.10.2 ' Imax' [$umol.cm^{-2}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.2.8.10.3 ' Km [$umol.ml^{-1}$]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.2.8.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.2.8.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.2.8.11 'number of xylem poles' = 10 [-]
2.2.8.12 'phosphorus' (Barber 1995)
2.2.8.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.2.8.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.2.8.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.2.8.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.2.8.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.2.8.13 'potassium' (Barber 1995)
2.2.8.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.2.8.13.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.2.8.13.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.2.8.13.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.2.8.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.8.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1 1 1}
2.2.8.15 'regular topology' = 3 [-]
2.2.8.16 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.2.8.17 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.8.18 'root class id' = 101 [-]
2.2.8.19 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)

2.2.8.20 'root hair diameter' = 0.0005 [cm]
2.2.8.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.8.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.2.8.23 'topology offset' = 0 [-]
2.2.9 'nodalroots2'
2.2.9.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.07 10 0.145 1000 0.145} (Burton 2010)
2.2.9.2 'branch list'
2.2.9.2.1 'lateral'
2.2.9.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.9.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.2.9.2.1.3 'length root tip' = 10.93 [cm]
2.2.9.3 'branching angle' = 150 [degrees]
2.2.9.4 'density' = 0.094 [$g.cm^{-3}$]
2.2.9.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.133 7 0.128 100 0.128} (Burton, University Park, Unpublished)
2.2.9.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.2.9.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.2.9.8 'length root tip without xylem vessels' = 2 [cm]
2.2.9.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.2.9.10 'nitrate'
2.2.9.10.1 ' Cmin' = 0.001 [$umol.ml^{-1}$]
2.2.9.10.2 ' Imax' [$umol.cm^{-2}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.2.9.10.3 ' Km [$umol.ml^{-1}$]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.2.9.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.2.9.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.2.9.11 'number of xylem poles' = 18 [-]
2.2.9.12 'phosphorus' (Barber 1995)
2.2.9.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.2.9.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.2.9.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.2.9.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.2.9.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.2.9.13 'potassium' (Barber 1995)
2.2.9.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.2.9.13.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.2.9.13.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.2.9.13.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.2.9.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.9.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1 1 1}
2.2.9.15 'regular topology' = 0 [-]
2.2.9.16 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.2.9.17 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.9.18 'root class id' = 101 [-]

2.2.9.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.9.20 'root hair diameter' = 0.0005 [cm]
2.2.9.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.9.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.2.9.23 'topology offset' = 0 [-]
2.2.10 'nodalroots3'
2.2.10.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.09 10 0.19 1000 0.19} (Burton 2010)
2.2.10.2 'branch list'
2.2.10.2.1 'lateral'
2.2.10.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.10.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.2.10.2.1.3 'length root tip' = 10.93 [cm]
2.2.10.3 'branching angle' = 140 [degrees]
2.2.10.4 'density' = 0.094 [g.cm^{-3}]
2.2.10.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.155 7 0.182 100 0.155} (Burton, University Park, Unpublished)
2.2.10.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.2.10.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.2.10.8 'length root tip without xylem vessels' = 2 [cm]
2.2.10.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.2.10.10 'nitrate'
2.2.10.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.2.10.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.2.10.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.2.10.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.2.10.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.2.10.11 'number of xylem poles' = 24 [-]
2.2.10.12 'phosphorus' (Barber 1995)
2.2.10.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.2.10.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.2.10.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.2.10.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.2.10.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.2.10.13 'potassium' (Barber 1995)
2.2.10.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.2.10.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.2.10.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.2.10.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.2.10.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.10.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1 1 1}
2.2.10.15 'regular topology' = 0 [-]
2.2.10.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)

2.2.10.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.10.18 'root class id' = 101 [-]
2.2.10.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.10.20 'root hair diameter' = 0.0005 [cm]
2.2.10.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.10.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.2.10.23 'topology offset' = 0 [-]
2.2.11 'nodalroots4'
2.2.11.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.09 10 0.19 1000 0.19} (Burton 2010)
2.2.11.2 'branch list'
2.2.11.2.1 'lateral'
2.2.11.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.11.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.2.11.2.1.3 'length root tip' = 10.93 [cm]
2.2.11.3 'branching angle' = 130 [degrees]
2.2.11.4 'density' = 0.094 [g.cm^{-3}]
2.2.11.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.155 7 0.182 100 0.155}
2.2.11.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.2.11.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.2.11.8 'length root tip without xylem vessels' = 2 [cm]
2.2.11.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.2.11.10 'nitrate'
2.2.11.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.2.11.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.2.11.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.2.11.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.2.11.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.2.11.11 'number of xylem poles' = 32 [-]
2.2.11.12 'phosphorus' (Barber 1995)
2.2.11.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.2.11.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.2.11.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.2.11.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.2.11.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.2.11.13 'potassium' (Barber 1995)
2.2.11.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.2.11.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.2.11.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.2.11.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.2.11.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.11.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1 1 1}
2.2.11.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100

5e-06} (Groleau-Renaud et al. 1998)
2.2.11.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.11.17 'root class id' = 101 [-]
2.2.11.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.11.19 'root hair diameter' = 0.0005 [cm]
2.2.11.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.11.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.2.12 'primary root'
2.2.12.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.175 1000 0.175} (Burton 2010)
2.2.12.2 'branch list'
2.2.12.2.1 'lateral'
2.2.12.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.12.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.25 maximum=0.45
2.2.12.2.1.3 'length root tip' = 10.93 [cm]
2.2.12.2.2 'seminal'
2.2.12.2.2.1 'allow branches to form above ground' = 0 [-]
2.2.12.2.2.2 'branching frequency' = 1 [cm]
2.2.12.2.2.3 'branching time offset' = 1 [day]
2.2.12.2.2.4 'max number of branches' = 5 [#]
2.2.12.2.2.5 'number of branches/whorl' = 5 [#]
2.2.12.3 'branching angle' = 0 [degrees]
2.2.12.4 'density' = 0.094 [g.cm^{-3}]
2.2.12.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.103 7 0.086 100 0.086} (Burton, University Park, Unpublished)
2.2.12.6 'gravitropism' = 0.01 [-]
2.2.12.7 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.015 maximum=-0.005
2.2.12.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 4.5 28 4.5 38 0 1000 0}
2.2.12.9 'length root tip without xylem vessels' = 2 [cm]
2.2.12.10 'nitrate'
2.2.12.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.2.12.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 2.3 2 1.92 40 1.92}
2.2.12.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0105 2 0.0161 40 0.0161}
2.2.12.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.2.12.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.2.12.11 'number of xylem poles' = 8 [-]
2.2.12.12 'phosphorus' (Barber 1995)
2.2.12.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.2.12.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.2.12.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.2.12.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.2.12.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.2.12.13 'potassium' (Barber 1995)
2.2.12.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.2.12.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]

2.2.12.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.2.12.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.2.12.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.12.14 'radial hydraulic conductivity' [cm.day^{-1}.hPa^{-1}]=f{'time since planting'} [day] x,y pairs : {0 0 1 0.000216 10 0.000216 20 0.000216 30 0.000116 40 5e-05 60 0}
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} (Fan et al. 2003)
2.2.12.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.2.12.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.12.18 'root class id' = 100 [-]
2.2.12.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.12.20 'root hair diameter' = 0.0005 [cm]
2.2.12.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.12.22 'soil impedence' = 0.05 [-]
2.2.12.23 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.2.13 'resources'
2.2.13.1 'carbon to dry weight ratio' = 0.45 [100%]
2.2.13.2 '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}
2.2.13.3 '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}
2.2.13.4 'carbon cost of nitrate uptake' = 1.392e-05 [g.umol^{-1}]
2.2.13.5 'max carbon allocation2 shoot' = 0.82 [100%]
2.2.13.6 'nitrate'
2.2.13.6.1 'initial nutrient uptake' = 285 [umol]
2.2.13.7 'phosphorus' (Barber 1995)
2.2.13.7.1 'initial nutrient uptake' = 20 [umol]
2.2.13.8 'potassium' (Barber 1995)
2.2.13.8.1 'initial nutrient uptake' = 27 [umol]
2.2.13.9 'reserve allocation rate' [%.day^{-1}]=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}
2.2.13.10 'seed size' = 0.15 [g]
2.2.14 'seminal'
2.2.14.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.158 1000 0.158} (Burton 2010)
2.2.14.2 'branch list'
2.2.14.2.1 'lateral'
2.2.14.2.1.1 'allow branches to form above ground' = 0 [-]
2.2.14.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.05 maximum=0.25
2.2.14.2.1.3 'length root tip' = 10.93 [cm]
2.2.14.3 'branching angle' = 90 [degrees]
2.2.14.4 'density' = 0.094 [g.cm^{-3}]
2.2.14.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.083 7 0.072 100 0.072} (Burton, University Park, Unpublished)

2.2.14.6 'gravitropism' = 0.004 [-]
2.2.14.7 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.035 maximum=-0.025
2.2.14.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.5 2 4.5 28 4.5 38 0 100 0}
2.2.14.9 'length root tip without xylem vessels' = 2 [cm]
2.2.14.10 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.2.14.11 'nitrate'
2.2.14.11.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.2.14.11.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 2.3 2 1.92 40 1.92}
2.2.14.11.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0105 2 0.0161 40 0.0161}
2.2.14.11.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.2.14.11.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.2.14.12 'number of xylem poles' = 6 [-]
2.2.14.13 'phosphorus' (Barber 1995)
2.2.14.13.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.2.14.13.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.2.14.13.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.2.14.13.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.2.14.13.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.2.14.14 'potassium' (Barber 1995)
2.2.14.14.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.2.14.14.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.2.14.14.3 ' Km' = 0.014 [umol.ml^{-1}]
2.2.14.14.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.2.14.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.2.14.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.2.14.16 'regular topology' = 1 [-]
2.2.14.17 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.2.14.18 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.2.14.19 'root class id' = 99 [-]
2.2.14.20 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.14.21 'root hair diameter' = 0.0005 [cm]
2.2.14.22 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.2.14.23 'soil impedence' = 0.02 [-]
2.2.14.24 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.2.15 'shoot'
2.2.15.1 'area per plant' = 1600 [cm2]
2.2.15.2 'extinction coefficient' = 0.85 [-]
2.2.15.3 'leaf area expantion rate' [cm2.day^{-1}]=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} (Zhang and Postma, University Park, unpublished)

2.2.15.3.1 'multiplier' = 1.2 [-]

2.2.15.4 'light use efficiency' = 3.8e-07 [g.umol-1] (Stirling et al. 1994; Postma, University Park, unpublished)

2.2.15.5 'nitrate'

2.2.15.5.1 'leaf minimal nutrient concentration' [umol.g^{-1}]=f{'time'} [day] x,y pairs :{0 1200 80 800}

2.2.15.5.2 'leaf optimal nutrient concentration' [umol.g^{-1}]=f{'time'} [day] x,y pairs :{0 2500 80 1500} (Zhang and Postma, University Park, Unpublished; Alexandrova & Donov 2003; Chevalier & Schrader 1977)

2.2.15.5.3 'stem minimal nutrient concentration' = 400 [umol.g^{-1}]

2.2.15.5.4 'stem optimal nutrient concentration' = 800 [umol.g^{-1}]

2.2.15.6 'phosphorus'

2.2.15.6.1 'leaf minimal nutrient concentration' = 35 [umol.g^{-1}]

2.2.15.6.2 'leaf optimal nutrient concentration' = 70 [umol.g-1] (Zhang and Postma, University Park, unpublished)

2.2.15.6.3 'stem minimal nutrient concentration' = 15 [umol.g^{-1}]

2.2.15.6.4 'stem optimal nutrient concentration' = 30 [umol.g^{-1}]

2.2.15.7 'potassium'

2.2.15.7.1 'leaf minimal nutrient concentration' = 273 [umol.g^{-1}]

2.2.15.7.2 'leaf optimal nutrient concentration' = 508 [umol.g-1] (Leigh & Jones 1984)

2.2.15.7.3 'stem minimal nutrient concentration' = 117 [umol.g^{-1}]

2.2.15.7.4 'stem optimal nutrient concentration' = 250 [umol.g^{-1}]

2.2.15.8 'relative potential transpiration' = 100 [cm3.g-1] (Baldocchi 1994)

2.2.15.9 'relative respiration rate leafs' = 0.04 [g.g-1.day-1] (Postma, University Park, Unpublished)

2.2.15.10 'relative respiration rate stems' = 0.02 [g.g^{-1}.day^{-1}]

2.2.15.11 'specific leaf area' [g.cm^{-2}]=f{'time'} [day] x,y pairs :{0 0.0015 24 0.0026 50 0.0032 100 0.0032} (van Heemst 1988; Jacob & Lawlor 1991; Jaramillo, University Park, unpublished)

2.2.16 'stress impact factors'

2.2.16.1 'impact on:leaf area expantion rate'

2.2.16.1.1 'impact by:nitrate' [-]=f{'nitrate stress factor'} [-] x,y pairs :{0 0 0.3 0.1 1 1} (Sinclair & Horie 1989)

2.2.16.1.2 'impact by:phosphorus' [-]=f{'phosphorus stress factor'} [-] x,y pairs :{0 0 1 1} (Lynch et al. 1991; Usuda & Shimogawara 1991)

2.2.16.1.3 'impact by:potassium' [-]=f{'potassium stress factor'} [-] x,y pairs :{0 0 0.2 0.5 1 1}

2.2.16.2 'impact on:photosynthesis'

2.2.16.2.1 'impact by:nitrate' [-]=f{'nitrate stress factor'} [-] x,y pairs :{0 0 0.4 0.5 1 1} (Sinclair & Horie 1989)

2.2.16.2.2 'impact by:phosphorus' [-]=f{'phosphorus stress factor'} [-] x,y pairs :{0 0.5 0.5 1 1 1} (Lynch et al. 1991; Usuda & Shimogawara 1991)

2.2.16.2.3 'impact by:potassium' [-]=f{'potassium stress factor'} [-] x,y pairs :{0 0 1 1}

2.3 'H99'

2.3.1 'braceroots'

2.3.1.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.11 1000 0.11} (Burton 2010)
2.3.1.2 'branch list'
2.3.1.2.1 'lateral of crown roots'
2.3.1.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.1.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.3.1.2.1.3 'branching spatial offset' = 12 [cm]
2.3.1.2.1.4 'length root tip' = 10.93 [cm]
2.3.1.2.1.5 'number of branches/whorl' = 1 [#]
2.3.1.3 'branching angle' = 140 [degrees]
2.3.1.4 'density' = 0.094 [$g.cm^{-3}$]
2.3.1.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.23 7 0.196 100 0.196} (Burton, University Park, Unpublished)
2.3.1.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.3.1.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0}
2.3.1.8 'length root tip without xylem vessels' = 2 [cm]
2.3.1.9 'longitudinal growth rate multiplier' [cm]=f{'uniform distribution'} minimum=0.7 maximum=1
2.3.1.10 'nitrate'
2.3.1.10.1 ' Cmin' = 0.001 [$umol.ml^{-1}$]
2.3.1.10.2 ' Imax' [$umol.cm^{-2}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.3.1.10.3 ' Km [$umol.ml^{-1}$]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.3.1.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.3.1.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.3.1.11 'number of xylem poles' = 40 [-]
2.3.1.12 'phosphorus' (Barber 1995)
2.3.1.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.3.1.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.3.1.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.3.1.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.3.1.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.3.1.13 'potassium' (Barber 1995)
2.3.1.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.3.1.13.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.3.1.13.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.3.1.13.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.3.1.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.1.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.1.15 'regular topology' = 4 [-]
2.3.1.16 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.3.1.17 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.1.18 'root class id' = 102 [-]
2.3.1.19 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.1.20 'root hair diameter' = 0.0005 [cm]
2.3.1.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20

(Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.1.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.3.2 'braceroots2'
2.3.2.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.03 10 0.03 1000 0.03} (Burton 2010)
2.3.2.2 'branch list'
2.3.2.2.1 'lateral of crown roots'
2.3.2.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.2.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.4
2.3.2.2.1.3 'branching spatial offset' = 15 [cm]
2.3.2.2.1.4 'length root tip' = 10.93 [cm]
2.3.2.2.1.5 'number of branches/whorl' = 1 [#]
2.3.2.3 'branching angle' = 130 [degrees]
2.3.2.4 'density' = 0.094 [$g.cm^{-3}$]
2.3.2.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.26 7 0.21 100 0.21} (Burton, University Park, Unpublished)
2.3.2.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.3.2.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0}
2.3.2.8 'length root tip without xylem vessels' = 2 [cm]
2.3.2.9 'longitudinal growth rate multiplier' [cm]=f{'uniform distribution'} minimum=0.7 maximum=1
2.3.2.10 'nitrate'
2.3.2.10.1 ' Cmin' = 0.001 [$umol.ml^{-1}$]
2.3.2.10.2 ' Imax' [$umol.cm^{-2}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.3.2.10.3 ' Km [$umol.ml^{-1}$]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.3.2.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.3.2.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.3.2.11 'number of xylem poles' = 48 [-]
2.3.2.12 'phosphorus' (Barber 1995)
2.3.2.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.3.2.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.3.2.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.3.2.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.3.2.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.3.2.13 'potassium' (Barber 1995)
2.3.2.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.3.2.13.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.3.2.13.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.3.2.13.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.3.2.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.2.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.2.15 'regular topology' = 3 [-]
2.3.2.16 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.3.2.17 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.2.18 'root class id' = 102 [-]
2.3.2.19 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0

2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.2.20 'root hair diameter' = 0.0005 [cm]
2.3.2.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.2.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.3.3 'finelateral'
2.3.3.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.3.3.2 'branch list'
2.3.3.2.1 'finelateral2'
2.3.3.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.3.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.4 maximum=0.6
2.3.3.2.1.3 'length root tip' = 1.5 [cm]
2.3.3.3 'branching angle' = 62.83 [degrees]
2.3.3.4 'density' = 0.094 [$g.cm^{-3}$]
2.3.3.5 'diameter' = 0.025 [cm]
2.3.3.6 'gravitropism.v2' = 0 0 0 [cm]
2.3.3.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.01 1 0.35 6 0 1000 0}
2.3.3.8 'length root tip without xylem vessels' = 2 [cm]
2.3.3.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.3.3.10 'nitrate'
2.3.3.10.1 ' Cmin' = 0.0017 [$umol.ml^{-1}$]
2.3.3.10.2 ' Imax' = 1.27 [$umol.cm^{-2}.day^{-1}$]
2.3.3.10.3 ' Km' = 0.0027 [$umol.ml^{-1}$]
2.3.3.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.3.3.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.3.3.11 'number of xylem poles' = 4 [-]
2.3.3.12 'phosphorus' (Barber 1995)
2.3.3.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.3.3.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.3.3.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.3.3.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.3.3.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.3.3.13 'potassium' (Barber 1995)
2.3.3.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.3.3.13.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.3.3.13.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.3.3.13.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.3.3.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.3.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.3.15 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 1e-06}
2.3.3.16 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.3.17 'root class id' = 98 [-]
2.3.3.18 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.3.19 'root hair diameter' = 0.0005 [cm]

2.3.3.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.3.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.3.4 'finelateral2'
2.3.4.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.3.4.2 'branch list'
2.3.4.3 'branching angle' = 62.83 [degrees]
2.3.4.4 'density' = 0.094 [$g.cm^{-3}$]
2.3.4.5 'diameter' = 0.015 [cm]
2.3.4.6 'gravitropism.v2' = 0 0 0 [cm]
2.3.4.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.001 1 0.28 4 0 1000 0}
2.3.4.8 'length root tip without xylem vessels' = 2 [cm]
2.3.4.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.3.4.10 'nitrate'
2.3.4.10.1 ' Cmin' = 0.0017 [$umol.ml^{-1}$]
2.3.4.10.2 ' Imax' = 1.27 [$umol.cm^{-2}.day^{-1}$]
2.3.4.10.3 ' Km' = 0.0027 [$umol.ml^{-1}$]
2.3.4.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.3.4.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.3.4.11 'number of xylem poles' = 4 [-]
2.3.4.12 'phosphorus' (Barber 1995)
2.3.4.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.3.4.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.3.4.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.3.4.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.3.4.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.3.4.13 'potassium' (Barber 1995)
2.3.4.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.3.4.13.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.3.4.13.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.3.4.13.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]
2.3.4.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.4.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.4.15 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 1e-06}
2.3.4.16 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.4.17 'root class id' = 98 [-]
2.3.4.18 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.4.19 'root hair diameter' = 0.0005 [cm]
2.3.4.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.4.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.3.5 'mesocotyl'
2.3.5.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.3.5.2 'branch list'

2.3.5.2.1 'braceroots'
2.3.5.2.1.1 'allometric scaling' = 1 [-]
2.3.5.2.1.2 'branching spatial offset' = 4 [cm]
2.3.5.2.1.3 'branching time offset' = 25 [day]
2.3.5.2.1.4 'number of branches/whorl' = 14 [#]
2.3.5.2.2 'braceroots2'
2.3.5.2.2.1 'allometric scaling' = 1 [-]
2.3.5.2.2.2 'branching delay' = 14 [day]
2.3.5.2.2.3 'branching frequency' = 5 [cm]
2.3.5.2.2.4 'branching spatial offset' = 7 [cm]
2.3.5.2.2.5 'branching time offset' = 36 [day]
2.3.5.2.2.6 'number of branches/whorl' = 20 [#]
2.3.5.2.3 'nodalroots'
2.3.5.2.3.1 'branching spatial offset' = 1.5 [cm]
2.3.5.2.3.2 'branching time offset' = 9 [day]
2.3.5.2.3.3 'number of branches/whorl' = 4 [#]
2.3.5.2.4 'nodalroots2'
2.3.5.2.4.1 'allometric scaling' = 1 [-]
2.3.5.2.4.2 'branching spatial offset' = 1.9 [cm]
2.3.5.2.4.3 'branching time offset' = 17 [day]
2.3.5.2.4.4 'number of branches/whorl' = 5 [#]
2.3.5.2.5 'nodalroots3'
2.3.5.2.5.1 'allometric scaling' = 1 [-]
2.3.5.2.5.2 'branching spatial offset' = 2.1 [cm]
2.3.5.2.5.3 'branching time offset' = 22 [day]
2.3.5.2.5.4 'number of branches/whorl' = 6 [#]
2.3.5.3 'density' = 0.094 [$g.cm^{-3}$]
2.3.5.4 'diameter' = 0.15 [cm]
2.3.5.5 'gravitropism' =-1 [-]
2.3.5.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=0.5 maximum=1
2.3.5.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 1 1 2 2 2 3 2 5 0 1000 0}
2.3.5.8 'length root tip without xylem vessels' = 2 [cm]
2.3.5.9 'nitrate'
2.3.5.9.1 ' Cmin' = 0 [$umol.ml^{-1}$]
2.3.5.9.2 ' Imax' = 0 [$umol.cm^{-2}.day^{-1}$]
2.3.5.9.3 ' Km' = 1 [$umol.ml^{-1}$]
2.3.5.9.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.3.5.9.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.3.5.10 'number of xylem poles' = 61 [-]
2.3.5.11 'phosphorus' (Barber 1995)
2.3.5.11.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.3.5.11.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.3.5.11.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.3.5.11.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.3.5.11.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.3.5.12 'potassium' (Barber 1995)
2.3.5.12.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.3.5.12.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.3.5.12.3 ' Km' = 0.014 [$umol.ml^{-1}$]

2.3.5.12.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.3.5.12.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.5.13 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.5.14 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.3.5.15 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.5.16 'root class id' = 97 [-]
2.3.5.17 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 0 2000 0}
2.3.5.18 'root hair diameter' = 0.0005 [cm]
2.3.5.19 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.5.20 'soil impedence' = 0.3 [-]
2.3.5.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.3 maximum=0.3
2.3.5.22 'top boundary' = 0 [-]
2.3.6 'lateral'
2.3.6.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.3.6.2 'branch list'
2.3.6.2.1 'finelateral'
2.3.6.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.6.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.15 maximum=0.35
2.3.6.2.1.3 'length root tip' = 4 [cm]
2.3.6.3 'branching angle' = 90 [degrees]
2.3.6.4 'density' = 0.094 [g.cm^{-3}]
2.3.6.5 'diameter' = 0.04 [cm]
2.3.6.6 'gravitropism.v2' = 0 0 0 [cm]
2.3.6.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.2 3 0.4 7 1 11 0 1000 0}
2.3.6.8 'length root tip without xylem vessels' = 2 [cm]
2.3.6.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.05 maximum=1 mean=0.3 stdev=0.3
2.3.6.10 'nitrate'
2.3.6.10.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.3.6.10.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.3.6.10.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.3.6.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.3.6.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.3.6.11 'number of xylem poles' = 4 [-]
2.3.6.12 'phosphorus' (Barber 1995)
2.3.6.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.3.6.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.3.6.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.3.6.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.3.6.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.3.6.13 'potassium' (Barber 1995)
2.3.6.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.3.6.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.3.6.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.3.6.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]

2.3.6.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.6.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.6.15 'relative carbon cost of exudation' [$g.cm^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 5e-06 100 3e-06}
2.3.6.16 'relative respiration' [$g.g^{-1}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.6.17 'root class id' = 98 [-]
2.3.6.18 'root hair density' [$\#.cm^{-2}$]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.6.19 'root hair diameter' = 0.0005 [cm]
2.3.6.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.6.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.3.7 'lateral of crown roots'
2.3.7.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.3.7.2 'branch list'
2.3.7.2.1 'lateral'
2.3.7.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.7.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.25 maximum=0.35
2.3.7.2.1.3 'length root tip' = 5 [cm]
2.3.7.3 'branching angle' = 90 [degrees]
2.3.7.4 'density' = 0.094 [$g.cm^{-3}$]
2.3.7.5 'diameter' = 0.07 [cm]
2.3.7.6 'gravitropism' = 0 [-]
2.3.7.7 'gravitropism.v2' = 0 0 0 [cm]
2.3.7.8 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.1 1 0.5 3 1.2 12 1.2 18 0 1000 0}
2.3.7.9 'length root tip without xylem vessels' = 2 [cm]
2.3.7.10 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.1 maximum=1 mean=0.4 stdev=0.3
2.3.7.11 'nitrate'
2.3.7.11.1 ' Cmin' = 0.0017 [$umol.ml^{-1}$]
2.3.7.11.2 ' Imax' = 1.27 [$umol.cm^{-2}.day^{-1}$]
2.3.7.11.3 ' Km' = 0.0027 [$umol.ml^{-1}$]
2.3.7.11.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.3.7.11.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.3.7.12 'number of xylem poles' = 4 [-]
2.3.7.13 'phosphorus' (Barber 1995)
2.3.7.13.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.3.7.13.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.3.7.13.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.3.7.13.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.3.7.13.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.3.7.14 'potassium' (Barber 1995)
2.3.7.14.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]
2.3.7.14.2 ' Imax' = 0.467 [$umol.cm^{-2}.day^{-1}$]
2.3.7.14.3 ' Km' = 0.014 [$umol.ml^{-1}$]
2.3.7.14.4 'minimal nutrient concentration' = 117 [$umol.g^{-1}$]

2.3.7.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.7.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.7.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 4e-06}
2.3.7.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.7.18 'root class id' = 98 [-]
2.3.7.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.7.20 'root hair diameter' = 0.0005 [cm]
2.3.7.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.7.22 'soil impedence' = 0.05 [-]
2.3.7.23 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.3.7.24 'top boundary' = 1 [-]
2.3.8 'nodalroots'
2.3.8.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.03 10 0.06 20 0.06 1000 0.06} (Burton 2010)
2.3.8.2 'branch list'
2.3.8.2.1 'lateral'
2.3.8.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.8.2.1.2 'branching frequency' [cm]=f{'normal distribution'} minimum=0.03 maximum=0.3 mean=0.06667 stdev=0.03
2.3.8.2.1.3 'length root tip' = 10.93 [cm]
2.3.8.3 'branching angle' = 140 [degrees]
2.3.8.4 'density' = 0.094 [g.cm^{-3}]
2.3.8.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.069 7 0.099 100 0.069} (Burton, University Park, Unpublished)
2.3.8.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.3.8.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.3.8.8 'length root tip without xylem vessels' = 2 [cm]
2.3.8.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.3.8.10 'nitrate'
2.3.8.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.3.8.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.3.8.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.3.8.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.3.8.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.3.8.11 'number of xylem poles' = 10 [-]
2.3.8.12 'phosphorus' (Barber 1995)
2.3.8.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.3.8.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.3.8.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.3.8.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.3.8.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.3.8.13 'potassium' (Barber 1995)
2.3.8.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]

2.3.8.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.3.8.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.3.8.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.3.8.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.8.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.8.15 'regular topology' = 3 [-]
2.3.8.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.3.8.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.8.18 'root class id' = 101 [-]
2.3.8.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.8.20 'root hair diameter' = 0.0005 [cm]
2.3.8.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.8.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.3.8.23 'topology offset' = 0 [-]
2.3.9 'nodalroots2'
2.3.9.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.02 10 0.043 1000 0.043} (Burton 2010)
2.3.9.2 'branch list'
2.3.9.2.1 'lateral'
2.3.9.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.9.2.1.2 'branching frequency' [cm]=f{'normal distribution'} minimum=0.03 maximum=0.3 mean=0.06667 stdev=0.03
2.3.9.2.1.3 'length root tip' = 10.93 [cm]
2.3.9.3 'branching angle' = 135 [degrees]
2.3.9.4 'density' = 0.094 [g.cm^{-3}]
2.3.9.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.142 7 0.131 100 0.131} (Burton, University Park, Unpublished)
2.3.9.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.3.9.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.3.9.8 'length root tip without xylem vessels' = 2 [cm]
2.3.9.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.3.9.10 'nitrate'
2.3.9.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.3.9.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.3.9.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.3.9.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.3.9.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.3.9.11 'number of xylem poles' = 18 [-]
2.3.9.12 'phosphorus' (Barber 1995)
2.3.9.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.3.9.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.3.9.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.3.9.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]

2.3.9.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.3.9.13 'potassium' (Barber 1995)
2.3.9.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.3.9.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.3.9.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.3.9.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.3.9.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.9.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.9.15 'regular topology' = 0 [-]
2.3.9.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.3.9.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.9.18 'root class id' = 101 [-]
2.3.9.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.9.20 'root hair diameter' = 0.0005 [cm]
2.3.9.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.9.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.3.9.23 'topology offset' = 0 [-]
2.3.10 'nodalroots3'
2.3.10.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.04 10 0.077 1000 0.077} (Burton 2010)
2.3.10.2 'branch list'
2.3.10.2.1 'lateral'
2.3.10.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.10.2.1.2 'branching frequency' [cm]=f{'normal distribution'} minimum=0.03 maximum=0.3 mean=0.06667 stdev=0.03
2.3.10.2.1.3 'length root tip' = 10.93 [cm]
2.3.10.3 'branching angle' = 130 [degrees]
2.3.10.4 'density' = 0.094 [g.cm^{-3}]
2.3.10.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.199 7 0.159 100 0.159} (Burton, University Park, Unpublished)
2.3.10.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.3.10.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.3.10.8 'length root tip without xylem vessels' = 2 [cm]
2.3.10.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.3.10.10 'nitrate'
2.3.10.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.3.10.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.3.10.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.3.10.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.3.10.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.3.10.11 'number of xylem poles' = 24 [-]
2.3.10.12 'phosphorus' (Barber 1995)
2.3.10.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]

2.3.10.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.3.10.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.3.10.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.3.10.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.3.10.13 'potassium' (Barber 1995)
2.3.10.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.3.10.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.3.10.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.3.10.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.3.10.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.10.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.10.15 'regular topology' = 0 [-]
2.3.10.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.3.10.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.10.18 'root class id' = 101 [-]
2.3.10.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.10.20 'root hair diameter' = 0.0005 [cm]
2.3.10.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.10.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.3.10.23 'topology offset' = 0 [-]
2.3.11 'nodalroots4'
2.3.11.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.04 10 0.077 1000 0.077} (Burton 2010)
2.3.11.2 'branch list'
2.3.11.2.1 'lateral'
2.3.11.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.11.2.1.2 'branching frequency' [cm]=f{'normal distribution'} minimum=0.03 maximum=0.3 mean=0.06667 stdev=0.03
2.3.11.2.1.3 'length root tip' = 10.93 [cm]
2.3.11.3 'branching angle' = 130 [degrees]
2.3.11.4 'density' = 0.094 [g.cm^{-3}]
2.3.11.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.199 7 0.159 100 0.159} (Burton, University Park, Unpublished)
2.3.11.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.3.11.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.3.11.8 'length root tip without xylem vessels' = 2 [cm]
2.3.11.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.3.11.10 'nitrate'
2.3.11.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.3.11.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.3.11.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.3.11.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.3.11.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]

2.3.11.11 'number of xylem poles' = 32 [-]
2.3.11.12 'phosphorus' (Barber 1995)
2.3.11.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.3.11.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.3.11.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.3.11.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.3.11.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.3.11.13 'potassium' (Barber 1995)
2.3.11.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.3.11.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.3.11.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.3.11.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.3.11.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.11.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.11.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.3.11.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.11.17 'root class id' = 101 [-]
2.3.11.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.11.19 'root hair diameter' = 0.0005 [cm]
2.3.11.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.11.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.3.12 'primary root'
2.3.12.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.045 10 0.088 1000 0.088} (Burton 2010)
2.3.12.2 'branch list'
2.3.12.2.1 'lateral'
2.3.12.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.12.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.25 maximum=0.45
2.3.12.2.1.3 'length root tip' = 10.93 [cm]
2.3.12.2.2 'seminal'
2.3.12.2.2.1 'allow branches to form above ground' = 0 [-]
2.3.12.2.2.2 'branching frequency' = 1 [cm]
2.3.12.2.2.3 'branching time offset' = 1 [day]
2.3.12.2.2.4 'max number of branches' = 5 [#]
2.3.12.2.2.5 'number of branches/whorl' = 5 [#]
2.3.12.3 'branching angle' = 0 [degrees]
2.3.12.4 'density' = 0.094 [g.cm^{-3}]
2.3.12.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.105 7 0.084 100 0.084} (Burton, University Park, Unpublished)
2.3.12.6 'gravitropism' = 0.01 [-]
2.3.12.7 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.015 maximum=-0.005
2.3.12.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 4.5 28 4.5 38 0 1000 0}
2.3.12.9 'length root tip without xylem vessels' = 2 [cm]

2.3.12.10 'nitrate'
2.3.12.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.3.12.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 2.3 2 1.92 40 1.92}
2.3.12.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0105 2 0.0161 40 0.0161}
2.3.12.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.3.12.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.3.12.11 'number of xylem poles' = 8 [-]
2.3.12.12 'phosphorus' (Barber 1995)
2.3.12.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.3.12.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.3.12.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.3.12.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.3.12.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.3.12.13 'potassium' (Barber 1995)
2.3.12.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.3.12.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.3.12.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.3.12.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.3.12.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.12.14 'radial hydraulic conductivity' [cm.day^{-1}.hPa^{-1}]=f{'time since planting'} [day] x,y pairs : {0 0 1 0.000216 10 0.000216 20 0.000216 30 0.000116 40 5e-05 60 0}
2.3.12.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.12.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.3.12.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.12.18 'root class id' = 100 [-]
2.3.12.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.12.20 'root hair diameter' = 0.0005 [cm]
2.3.12.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.12.22 'soil impedence' = 0.05 [-]
2.3.12.23 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.3.13 'resources'
2.3.13.1 'carbon to dry weight ratio' = 0.45 [100%]
2.3.13.2 '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}
2.3.13.3 '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}
2.3.13.4 'carbon cost of nitrate uptake' = 1.392e-05 [g.umol^{-1}]
2.3.13.5 'max carbon allocation2 shoot' = 0.82 [100%]
2.3.13.6 'nitrate'
2.3.13.6.1 'initial nutrient uptake' = 285 [umol]
2.3.13.7 'phosphorus' (Barber 1995)
2.3.13.7.1 'initial nutrient uptake' = 20 [umol]
2.3.13.8 'potassium' (Barber 1995)
2.3.13.8.1 'initial nutrient uptake' = 27 [umol]

2.3.13.9 'reserve allocation rate' [%.day^{-1}]=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}
2.3.13.10 'seed size' = 0.15 [g]
2.3.14 'seminal'
2.3.14.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.042 10 0.083 1000 0.083} (Burton 2010)
2.3.14.2 'branch list'
2.3.14.2.1 'lateral'
2.3.14.2.1.1 'allow branches to form above ground' = 0 [-]
2.3.14.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.05 maximum=0.25
2.3.14.2.1.3 'length root tip' = 10.93 [cm]
2.3.14.3 'branching angle' = 90 [degrees]
2.3.14.4 'density' = 0.094 [g.cm^{-3}]
2.3.14.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.075 7 0.071 100 0.071} (Burton, University Park, Unpublished)
2.3.14.6 'gravitropism' = 0.004 [-]
2.3.14.7 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.035 maximum=-0.025
2.3.14.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.5 2 4.5 28 4.5 38 0 100 0}
2.3.14.9 'length root tip without xylem vessels' = 2 [cm]
2.3.14.10 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.3.14.11 'nitrate'
2.3.14.11.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.3.14.11.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 2.3 2 1.92 40 1.92}
2.3.14.11.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0105 2 0.0161 40 0.0161}
2.3.14.11.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.3.14.11.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.3.14.12 'number of xylem poles' = 6 [-]
2.3.14.13 'phosphorus' (Barber 1995)
2.3.14.13.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.3.14.13.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.3.14.13.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.3.14.13.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.3.14.13.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.3.14.14 'potassium' (Barber 1995)
2.3.14.14.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.3.14.14.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.3.14.14.3 ' Km' = 0.014 [umol.ml^{-1}]
2.3.14.14.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.3.14.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.3.14.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.3.14.16 'regular topology' = 1 [-]
2.3.14.17 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.3.14.18 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.3.14.19 'root class id' = 99 [-]

2.3.14.20 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.14.21 'root hair diameter' = 0.0005 [cm]
2.3.14.22 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.3.14.23 'soil impedence' = 0.02 [-]
2.3.14.24 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.3.15 'shoot'
2.3.15.1 'area per plant' = 1600 [cm2]
2.3.15.2 'extinction coefficient' = 0.85 [-]
2.3.15.3 'leaf area expantion rate' [cm2.day^{-1}]=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} (Zhang and Postma, University Park, unpublished)
2.3.15.3.1 'multiplier' = 0.8 [-]
2.3.15.4 'light use efficiency' = 3.8e-07 [g.umol-1] (Stirling et al. 1994; Postma, University Park, unpublished)
2.3.15.5 'nitrate'
2.3.15.5.1 'leaf minimal nutrient concentration' [umol.g^{-1}]=f{'time'} [day] x,y pairs :{0 1200 80 800}
2.3.15.5.2 'leaf optimal nutrient concentration' [umol.g^{-1}]=f{'time'} [day] x,y pairs :{0 2500 80 1500} (Zhang and Postma, University Park, Unpublished; Alexandrova & Donov 2003; Chevalier & Schrader 1977)
2.3.15.5.3 'stem minimal nutrient concentration' = 400 [umol.g^{-1}]
2.3.15.5.4 'stem optimal nutrient concentration' = 800 [umol.g^{-1}]
2.3.15.6 'phosphorus'
2.3.15.6.1 'leaf minimal nutrient concentration' = 35 [umol.g^{-1}]
2.3.15.6.2 'leaf optimal nutrient concentration' = 70 [umol.g-1] (Zhang and Postma, University Park, unpublished)
2.3.15.6.3 'stem minimal nutrient concentration' = 15 [umol.g^{-1}]
2.3.15.6.4 'stem optimal nutrient concentration' = 30 [umol.g^{-1}]
2.3.15.7 'potassium'
2.3.15.7.1 'leaf minimal nutrient concentration' = 273 [umol.g^{-1}]
2.3.15.7.2 'leaf optimal nutrient concentration' = 508 [umol.g-1] (Leigh & Jones 1984)
2.3.15.7.3 'stem minimal nutrient concentration' = 117 [umol.g^{-1}]
2.3.15.7.4 'stem optimal nutrient concentration' = 250 [umol.g^{-1}]
2.3.15.8 'relative potential transpiration' = 100 [cm3.g-1] (Baldocchi 1994)
2.3.15.9 'relative respiration rate leafs' = 0.04 [g.g-1.day-1] (Postma, University Park, Unpublished)
2.3.15.10 'relative respiration rate stems' = 0.02 [g.g^{-1}.day^{-1}]
2.3.15.11 'specific leaf area' [g.cm^{-2}]=f{'time'} [day] x,y pairs :{0 0.0015 24 0.0026 50 0.0032

100 0.0032} (van Heemst 1988; Jacob & Lawlor 1991; Jaramillo, University Park, unpublished)
2.3.16 'stress impact factors'
2.3.16.1 'impact on:leaf area expantion rate'
2.3.16.1.1 'impact by:nitrate' [-]=f{'nitrate stress factor'} [-] x,y pairs :{0 0 0.3 0.1 1 1} (Sinclair & Horie 1989)
2.3.16.1.2 'impact by:phosphorus' [-]=f{'phosphorus stress factor'} [-] x,y pairs :{0 0 1 1} (Lynch et al. 1991; Usuda & Shimogawara 1991)
2.3.16.1.3 'impact by:potassium' [-]=f{'potassium stress factor'} [-] x,y pairs :{0 0 0.2 0.5 1 1}
2.3.16.2 'impact on:photosynthesis'
2.3.16.2.1 'impact by:nitrate' [-]=f{'nitrate stress factor'} [-] x,y pairs :{0 0 0.4 0.5 1 1} (Sinclair & Horie 1989)
2.3.16.2.2 'impact by:phosphorus' [-]=f{'phosphorus stress factor'} [-] x,y pairs :{0 0.5 0.5 1 1 1} (Lynch et al. 1991; Usuda & Shimogawara 1991)
2.3.16.2.3 'impact by:potassium' [-]=f{'potassium stress factor'} [-] x,y pairs :{0 0 1 1}

2.4 'w64a'
2.4.1 'braceroots'
2.4.1.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.11 1000 0.11} (Burton 2010)
2.4.1.2 'branch list'
2.4.1.2.1 'lateral of crown roots'
2.4.1.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.1.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.3
2.4.1.2.1.3 'branching spatial offset' = 12 [cm]
2.4.1.2.1.4 'length root tip' = 10.93 [cm]
2.4.1.2.1.5 'number of branches/whorl' = 1 [#]
2.4.1.3 'branching angle' = 140 [degrees]
2.4.1.4 'density' = 0.094 [$g.cm^{-3}$]
2.4.1.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.223 7 0.145 100 0.145} (Burton, University Park, Unpublished)
2.4.1.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.4.1.7 'growth rate' [$cm.day^{-1}$]=f{'age'} [day] x,y pairs :{0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0}
2.4.1.8 'length root tip without xylem vessels' = 2 [cm]
2.4.1.9 'longitudinal growth rate multiplier' [cm]=f{'uniform distribution'} minimum=0.7 maximum=1
2.4.1.10 'nitrate'
2.4.1.10.1 ' Cmin' = 0.001 [$umol.ml^{-1}$]
2.4.1.10.2 ' Imax' [$umol.cm^{-2}.day^{-1}$]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.4.1.10.3 ' Km [$umol.ml^{-1}$]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.4.1.10.4 'minimal nutrient concentration' = 600 [$umol.g^{-1}$]
2.4.1.10.5 'optimal nutrient concentration' = 1200 [$umol.g^{-1}$]
2.4.1.11 'number of xylem poles' = 40 [-]
2.4.1.12 'phosphorus' (Barber 1995)
2.4.1.12.1 ' Cmin' = 0.0002 [$umol.ml^{-1}$]
2.4.1.12.2 ' Imax' = 0.0555 [$umol.cm^{-2}.day^{-1}$]
2.4.1.12.3 ' Km' = 0.00545 [$umol.ml^{-1}$]
2.4.1.12.4 'minimal nutrient concentration' = 30 [$umol.g^{-1}$]
2.4.1.12.5 'optimal nutrient concentration' = 60 [$umol.g^{-1}$]
2.4.1.13 'potassium' (Barber 1995)
2.4.1.13.1 ' Cmin' = 0.002 [$umol.ml^{-1}$]

2.4.1.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.1.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.1.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.1.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.1.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.1.15 'regular topology' = 4 [-]
2.4.1.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.4.1.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.1.18 'root class id' = 102 [-]
2.4.1.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.1.20 'root hair diameter' = 0.0005 [cm]
2.4.1.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.1.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.4.2 'braceroots2'
2.4.2.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.11 1000 0.11} (Burton 2010)
2.4.2.2 'branch list'
2.4.2.2.1 'lateral of crown roots'
2.4.2.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.2.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.1 maximum=0.4
2.4.2.2.1.3 'branching spatial offset' = 15 [cm]
2.4.2.2.1.4 'length root tip' = 10.93 [cm]
2.4.2.2.1.5 'number of branches/whorl' = 1 [#]
2.4.2.3 'branching angle' = 130 [degrees]
2.4.2.4 'density' = 0.094 [g.cm^{-3}]
2.4.2.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.253 7 0.175 100 0.175} (Burton, University Park, Unpublished)
2.4.2.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.4.2.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 5 1 10 4.5 17 4.5 22 0 1000 0}
2.4.2.8 'length root tip without xylem vessels' = 2 [cm]
2.4.2.9 'longitudinal growth rate multiplier' [cm]=f{'uniform distribution'} minimum=0.7 maximum=1
2.4.2.10 'nitrate'
2.4.2.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.4.2.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.4.2.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.4.2.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.2.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.2.11 'number of xylem poles' = 48 [-]
2.4.2.12 'phosphorus' (Barber 1995)
2.4.2.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.2.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.2.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.2.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]

2.4.2.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.2.13 'potassium' (Barber 1995)
2.4.2.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.2.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.2.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.2.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.2.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.2.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.2.15 'regular topology' = 3 [-]
2.4.2.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.4.2.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.2.18 'root class id' = 102 [-]
2.4.2.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.2.20 'root hair diameter' = 0.0005 [cm]
2.4.2.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.2.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.03 maximum=0.03
2.4.3 'finelateral'
2.4.3.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.4.3.2 'branch list'
2.4.3.2.1 'finelateral2'
2.4.3.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.3.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.4 maximum=0.6
2.4.3.2.1.3 'length root tip' = 1.5 [cm]
2.4.3.3 'branching angle' = 62.83 [degrees]
2.4.3.4 'density' = 0.094 [g.cm^{-3}]
2.4.3.5 'diameter' = 0.025 [cm]
2.4.3.6 'gravitropism.v2' = 0 0 0 [cm]
2.4.3.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.35 6 0 1000 0}
2.4.3.8 'length root tip without xylem vessels' = 2 [cm]
2.4.3.9 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.4.3.10 'nitrate'
2.4.3.10.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.4.3.10.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.4.3.10.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.4.3.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.3.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.3.11 'number of xylem poles' = 4 [-]
2.4.3.12 'phosphorus' (Barber 1995)
2.4.3.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.3.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.3.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.3.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.3.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]

2.4.3.13 'potassium' (Barber 1995)
2.4.3.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.3.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.3.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.3.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.3.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.3.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.3.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 1e-06}
2.4.3.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.3.17 'root class id' = 98 [-]
2.4.3.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.3.19 'root hair diameter' = 0.0005 [cm]
2.4.3.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.3.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.4.4 'finelateral2'
2.4.4.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.4.4.2 'branch list'
2.4.4.3 'branching angle' = 62.83 [degrees]
2.4.4.4 'density' = 0.094 [g.cm^{-3}]
2.4.4.5 'diameter' = 0.015 [cm]
2.4.4.6 'gravitropism.v2' = 0 0 0 [cm]
2.4.4.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.001 1 0.28 4 0 1000 0}
2.4.4.8 'length root tip without xylem vessels' = 2 [cm]
2.4.4.9 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.5 maximum=1.5 mean=1 stdev=0.1
2.4.4.10 'nitrate'
2.4.4.10.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.4.4.10.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.4.4.10.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.4.4.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.4.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.4.11 'number of xylem poles' = 4 [-]
2.4.4.12 'phosphorus' (Barber 1995)
2.4.4.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.4.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.4.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.4.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.4.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.4.13 'potassium' (Barber 1995)
2.4.4.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.4.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.4.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.4.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.4.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)

2.4.4.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.4.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 1e-06}
2.4.4.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.4.17 'root class id' = 98 [-]
2.4.4.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.4.19 'root hair diameter' = 0.0005 [cm]
2.4.4.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.4.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.4.5 'mesocotyl'
2.4.5.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.4.5.2 'branch list'
2.4.5.2.1 'braceroots'
2.4.5.2.1.1 'allometric scaling' = 1 [-]
2.4.5.2.1.2 'branching spatial offset' = 4 [cm]
2.4.5.2.1.3 'branching time offset' = 25 [day]
2.4.5.2.1.4 'number of branches/whorl' = 14 [#]
2.4.5.2.2 'braceroots2'
2.4.5.2.2.1 'allometric scaling' = 1 [-]
2.4.5.2.2.2 'branching delay' = 14 [day]
2.4.5.2.2.3 'branching frequency' = 5 [cm]
2.4.5.2.2.4 'branching spatial offset' = 7 [cm]
2.4.5.2.2.5 'branching time offset' = 36 [day]
2.4.5.2.2.6 'number of branches/whorl' = 20 [#]
2.4.5.2.3 'nodalroots'
2.4.5.2.3.1 'branching spatial offset' = 1.5 [cm]
2.4.5.2.3.2 'branching time offset' = 9 [day]
2.4.5.2.3.3 'number of branches/whorl' = 4 [#]
2.4.5.2.4 'nodalroots2'
2.4.5.2.4.1 'allometric scaling' = 1 [-]
2.4.5.2.4.2 'branching spatial offset' = 1.9 [cm]
2.4.5.2.4.3 'branching time offset' = 17 [day]
2.4.5.2.4.4 'number of branches/whorl' = 5 [#]
2.4.5.2.5 'nodalroots3'
2.4.5.2.5.1 'allometric scaling' = 1 [-]
2.4.5.2.5.2 'branching spatial offset' = 2.1 [cm]
2.4.5.2.5.3 'branching time offset' = 22 [day]
2.4.5.2.5.4 'number of branches/whorl' = 6 [#]
2.4.5.3 'density' = 0.094 [g.cm^{-3}]
2.4.5.4 'diameter' = 0.15 [cm]
2.4.5.5 'gravitropism' =-1 [-]
2.4.5.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=0.5 maximum=1
2.4.5.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 1 1 2 2 2 3 2 5 0 1000 0}
2.4.5.8 'length root tip without xylem vessels' = 2 [cm]
2.4.5.9 'nitrate'

2.4.5.9.1 ' Cmin' = 0 [umol.ml^{-1}]
2.4.5.9.2 ' Imax' = 0 [umol.cm^{-2}.day^{-1}]
2.4.5.9.3 ' Km' = 1 [umol.ml^{-1}]
2.4.5.9.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.5.9.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.5.10 'number of xylem poles' = 61 [-]
2.4.5.11 'phosphorus' (Barber 1995)
2.4.5.11.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.5.11.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.5.11.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.5.11.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.5.11.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.5.12 'potassium' (Barber 1995)
2.4.5.12.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.5.12.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.5.12.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.5.12.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.5.12.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.5.13 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.5.14 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.4.5.15 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.5.16 'root class id' = 97 [-]
2.4.5.17 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 0 2000 0}
2.4.5.18 'root hair diameter' = 0.0005 [cm]
2.4.5.19 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.5.20 'soil impedence' = 0.3 [-]
2.4.5.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.3 maximum=0.3
2.4.5.22 'top boundary' = 0 [-]
2.4.6 'lateral'
2.4.6.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.4.6.2 'branch list'
2.4.6.2.1 'finelateral'
2.4.6.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.6.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.15 maximum=0.35
2.4.6.2.1.3 'length root tip' = 4 [cm]
2.4.6.3 'branching angle' = 90 [degrees]
2.4.6.4 'density' = 0.094 [g.cm^{-3}]
2.4.6.5 'diameter' = 0.04 [cm]
2.4.6.6 'gravitropism.v2' = 0 0 0 [cm]
2.4.6.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.2 3 0.4 7 1 11 0 1000 0}
2.4.6.8 'length root tip without xylem vessels' = 2 [cm]
2.4.6.9 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.05 maximum=1 mean=0.3 stdev=0.3
2.4.6.10 'nitrate'
2.4.6.10.1 ' Cmin' = 0.0017 [umol.ml^{-1}]

2.4.6.10.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.4.6.10.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.4.6.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.6.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.6.11 'number of xylem poles' = 4 [-]
2.4.6.12 'phosphorus' (Barber 1995)
2.4.6.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.6.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.6.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.6.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.6.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.6.13 'potassium' (Barber 1995)
2.4.6.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.6.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.6.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.6.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.6.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.6.14 'radial hydraulic conductivity' [cm.day^{-1}.hPa^{-1}]=f{'time since planting'} [day] x,y pairs : {0 0 1 0.000416 60 0.000416}
2.4.6.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.6.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 3e-06}
2.4.6.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.6.18 'root class id' = 98 [-]
2.4.6.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.6.20 'root hair diameter' = 0.0005 [cm]
2.4.6.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.6.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.1 maximum=0.1
2.4.7 'lateral of crown roots'
2.4.7.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 100 0}
2.4.7.2 'branch list'
2.4.7.2.1 'lateral'
2.4.7.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.7.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.25 maximum=0.35
2.4.7.2.1.3 'length root tip' = 5 [cm]
2.4.7.3 'branching angle' = 90 [degrees]
2.4.7.4 'density' = 0.094 [g.cm^{-3}]
2.4.7.5 'diameter' = 0.07 [cm]
2.4.7.6 'gravitropism' = 0 [-]
2.4.7.7 'gravitropism.v2' = 0 0 0 [cm]
2.4.7.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.1 1 0.5 3 1.2 12 1.2 18 0 1000 0}
2.4.7.9 'length root tip without xylem vessels' = 2 [cm]
2.4.7.10 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.1 maximum=1 mean=0.4 stdev=0.3

2.4.7.11 'nitrate'
2.4.7.11.1 ' Cmin' = 0.0017 [umol.ml^{-1}]
2.4.7.11.2 ' Imax' = 1.27 [umol.cm^{-2}.day^{-1}]
2.4.7.11.3 ' Km' = 0.0027 [umol.ml^{-1}]
2.4.7.11.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.7.11.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.7.12 'number of xylem poles' = 4 [-]
2.4.7.13 'phosphorus' (Barber 1995)
2.4.7.13.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.7.13.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.7.13.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.7.13.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.7.13.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.7.14 'potassium' (Barber 1995)
2.4.7.14.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.7.14.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.7.14.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.7.14.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.7.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.7.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.7.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 4e-06}
2.4.7.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.7.18 'root class id' = 98 [-]
2.4.7.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.7.20 'root hair diameter' = 0.0005 [cm]
2.4.7.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.7.22 'soil impedence' = 0.05 [-]
2.4.7.23 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.4.8 'nodalroots'
2.4.8.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.03 10 0.065 20 0.065 1000 0.065} (Burton 2010)
2.4.8.2 'branch list'
2.4.8.2.1 'lateral'
2.4.8.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.8.2.1.2 'branching frequency' [cm]= f{'normal distribution'} minimum=0.03 maximum=0.3 mean=0.1 stdev=0.03
2.4.8.2.1.3 'length root tip' = 10.93 [cm]
2.4.8.3 'branching angle' = 155 [degrees]
2.4.8.4 'density' = 0.094 [g.cm^{-3}]
2.4.8.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.069 7 0.093 100 0.093} (Burton, University Park, Unpublished)
2.4.8.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.4.8.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.4.8.8 'length root tip without xylem vessels' = 2 [cm]

2.4.8.9 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.4.8.10 'nitrate'
2.4.8.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.4.8.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.4.8.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.4.8.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.8.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.8.11 'number of xylem poles' = 10 [-]
2.4.8.12 'phosphorus' (Barber 1995)
2.4.8.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.8.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.8.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.8.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.8.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.8.13 'potassium' (Barber 1995)
2.4.8.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.8.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.8.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.8.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.8.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.8.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.8.15 'regular topology' = 3 [-]
2.4.8.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.4.8.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.8.18 'root class id' = 101 [-]
2.4.8.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.8.20 'root hair diameter' = 0.0005 [cm]
2.4.8.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.8.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.4.8.23 'topology offset' = 0 [-]
2.4.9 'nodalroots2'
2.4.9.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.07 10 0.15 1000 0.15} (Burton 2010)
2.4.9.2 'branch list'
2.4.9.2.1 'lateral'
2.4.9.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.9.2.1.2 'branching frequency' [cm]= f{'normal distribution'} minimum=0.03 maximum=0.3 mean=0.1 stdev=0.03
2.4.9.2.1.3 'length root tip' = 10.93 [cm]
2.4.9.3 'branching angle' = 150 [degrees]
2.4.9.4 'density' = 0.094 [g.cm^{-3}]
2.4.9.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.108 7 0.103 100 0.103} (Burton, University Park, Unpublished)

2.4.9.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.4.9.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.4.9.8 'length root tip without xylem vessels' = 2 [cm]
2.4.9.9 'longitudinal growth rate multiplier' [cm]=f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.4.9.10 'nitrate'
2.4.9.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.4.9.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.4.9.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.4.9.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.9.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.9.11 'number of xylem poles' = 18 [-]
2.4.9.12 'phosphorus' (Barber 1995)
2.4.9.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.9.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.9.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.9.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.9.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.9.13 'potassium' (Barber 1995)
2.4.9.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.9.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.9.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.9.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.9.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.9.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.9.15 'regular topology' = 0 [-]
2.4.9.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.4.9.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.9.18 'root class id' = 101 [-]
2.4.9.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.9.20 'root hair diameter' = 0.0005 [cm]
2.4.9.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.9.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.4.9.23 'topology offset' = 0 [-]
2.4.10 'nodalroots3'
2.4.10.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.07 10 0.13 1000 0.13} (Burton 2010)
2.4.10.2 'branch list'
2.4.10.2.1 'lateral'
2.4.10.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.10.2.1.2 'branching frequency' [cm]= f{'normal distribution'} minimum=0.03 maximum=0.3 mean=0.1 stdev=0.03
2.4.10.2.1.3 'length root tip' = 10.93 [cm]
2.4.10.3 'branching angle' = 145 [degrees]

2.4.10.4 'density' = 0.094 [g.cm^{-3}]
2.4.10.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.145 7 0.128 100 0.128} (Burton, University Park, Unpublished)
2.4.10.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.4.10.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.4.10.8 'length root tip without xylem vessels' = 2 [cm]
2.4.10.9 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.4.10.10 'nitrate'
2.4.10.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.4.10.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.4.10.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.4.10.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.10.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.10.11 'number of xylem poles' = 24 [-]
2.4.10.12 'phosphorus' (Barber 1995)
2.4.10.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.10.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.10.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.10.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.10.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.10.13 'potassium' (Barber 1995)
2.4.10.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.10.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.10.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.10.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.10.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.10.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.10.15 'regular topology' = 0 [-]
2.4.10.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.4.10.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.10.18 'root class id' = 101 [-]
2.4.10.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.10.20 'root hair diameter' = 0.0005 [cm]
2.4.10.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.10.22 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.4.10.23 'topology offset' = 0 [-]
2.4.11 'nodalroots4'
2.4.11.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.07 10 0.15 1000 0.15} (Burton 2010)
2.4.11.2 'branch list'
2.4.11.2.1 'lateral'
2.4.11.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.11.2.1.2 'branching frequency' [cm]= f{'normal distribution'} minimum=0.03

maximum=0.3 mean=0.1 stdev=0.03
2.4.11.2.1.3 'length root tip' = 10.93 [cm]
2.4.11.3 'branching angle' = 130 [degrees]
2.4.11.4 'density' = 0.094 [g.cm^{-3}]
2.4.11.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.145 7 0.128 100 0.128} (Burton, University Park, Unpublished)
2.4.11.6 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.01 maximum=-0.005
2.4.11.7 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 1 3 4.5 28 4.5 38 0 1000 0}
2.4.11.8 'length root tip without xylem vessels' = 2 [cm]
2.4.11.9 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.4.11.10 'nitrate'
2.4.11.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.4.11.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 1.21 2 2.1 40 2.1}
2.4.11.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0157 2 0.0522 40 0.0522}
2.4.11.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.11.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.11.11 'number of xylem poles' = 32 [-]
2.4.11.12 'phosphorus' (Barber 1995)
2.4.11.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.11.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.11.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.11.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.11.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.11.13 'potassium' (Barber 1995)
2.4.11.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.11.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.11.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.11.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.11.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.11.14 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.11.15 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.4.11.16 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.11.17 'root class id' = 101 [-]
2.4.11.18 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.11.19 'root hair diameter' = 0.0005 [cm]
2.4.11.20 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.11.21 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.02 maximum=0.02
2.4.12 'primary root'
2.4.12.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.17 1000 0.17} (Burton 2010)
2.4.12.2 'branch list'
2.4.12.2.1 'lateral'
2.4.12.2.1.1 'allow branches to form above ground' = 0 [-]

2.4.12.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.25 maximum=0.45
2.4.12.2.1.3 'length root tip' = 10.93 [cm]
2.4.12.2.2 'seminal'
2.4.12.2.2.1 'allow branches to form above ground' = 0 [-]
2.4.12.2.2.2 'branching frequency' = 1 [cm]
2.4.12.2.2.3 'branching time offset' = 1 [day]
2.4.12.2.2.4 'max number of branches' = 5 [#]
2.4.12.2.2.5 'number of branches/whorl' = 5 [#]
2.4.12.3 'branching angle' = 0 [degrees]
2.4.12.4 'density' = 0.094 [g.cm^{-3}]
2.4.12.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.114 7 0.097 100 0.097} (Burton, University Park, Unpublished)
2.4.12.6 'gravitropism' = 0.01 [-]
2.4.12.7 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.015 maximum=-0.005
2.4.12.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 4.5 28 4.5 38 0 1000 0}
2.4.12.9 'length root tip without xylem vessels' = 2 [cm]
2.4.12.10 'nitrate'
2.4.12.10.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.4.12.10.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 2.3 2 1.92 40 1.92}
2.4.12.10.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0105 2 0.0161 40 0.0161}
2.4.12.10.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.12.10.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.12.11 'number of xylem poles' = 8 [-]
2.4.12.12 'phosphorus' (Barber 1995)
2.4.12.12.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.12.12.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]
2.4.12.12.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.12.12.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.12.12.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.12.13 'potassium' (Barber 1995)
2.4.12.13.1 ' Cmin' = 0.002 [umol.ml^{-1}]
2.4.12.13.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.12.13.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.12.13.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.12.13.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.12.14 'radial hydraulic conductivity' [cm.day^{-1}.hPa^{-1}]=f{'time since planting'} [day] x,y pairs :{0 0 1 0.000216 10 0.000216 20 0.000216 30 0.000116 40 5e-05 60 0}
2.4.12.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.12.16 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.4.12.17 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.12.18 'root class id' = 100 [-]
2.4.12.19 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.12.20 'root hair diameter' = 0.0005 [cm]
2.4.12.21 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20

(Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.12.22 'soil impedence' = 0.05 [-]
2.4.12.23 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.05 maximum=0.05
2.4.13 'resources'
2.4.13.1 'carbon to dry weight ratio' = 0.45 [100%]
2.4.13.2 '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}
2.4.13.3 '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}
2.4.13.4 'carbon cost of nitrate uptake' = 1.392e-05 [g.umol^{-1}]
2.4.13.5 'max carbon allocation2 shoot' = 0.82 [100%]
2.4.13.6 'nitrate'
2.4.13.6.1 'initial nutrient uptake' = 285 [umol]
2.4.13.7 'phosphorus' (Barber 1995)
2.4.13.7.1 'initial nutrient uptake' = 20 [umol]
2.4.13.8 'potassium' (Barber 1995)
2.4.13.8.1 'initial nutrient uptake' = 27 [umol]
2.4.13.9 'reserve allocation rate' [%.day^{-1}]=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}
2.4.13.10 'seed size' = 0.15 [g]
2.4.14 'seminal'
2.4.14.1 'aerenchyma formation' [100%]=f{'age'} [day] x,y pairs :{0 0 3 0 5 0.05 10 0.11 1000 0.11} (Burton 2010)
2.4.14.2 'branch list'
2.4.14.2.1 'lateral'
2.4.14.2.1.1 'allow branches to form above ground' = 0 [-]
2.4.14.2.1.2 'branching frequency' [cm]=f{'uniform distribution'} minimum=0.05 maximum=0.25
2.4.14.2.1.3 'length root tip' = 10.93 [cm]
2.4.14.3 'branching angle' = 90 [degrees]
2.4.14.4 'density' = 0.094 [g.cm^{-3}]
2.4.14.5 'diameter' [cm]=f{'age'} [day] x,y pairs :{0 0.089 7 0.071 100 0.071} (Burton, University Park, Unpublished)
2.4.14.6 'gravitropism' = 0.004 [-]
2.4.14.7 'gravitropism.v2' [cm]=f{'uniform distribution'} minimum=-0.035 maximum=-0.025
2.4.14.8 'growth rate' [cm.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.01 1 0.5 2 4.5 28 4.5 38 0 100 0}
2.4.14.9 'length root tip without xylem vessels' = 2 [cm]
2.4.14.10 'longitudinal growth rate multiplier' [cm]= f{'normal distribution'} minimum=0.6 maximum=1.2 mean=1 stdev=0.1
2.4.14.11 'nitrate'
2.4.14.11.1 ' Cmin' = 0.001 [umol.ml^{-1}]
2.4.14.11.2 ' Imax' [umol.cm^{-2}.day^{-1}]=f{'age'} [day] x,y pairs :{0 2.3 2 1.92 40 1.92}
2.4.14.11.3 ' Km [umol.ml^{-1}]=f{'age'} [day] x,y pairs :{0 0.0105 2 0.0161 40 0.0161}
2.4.14.11.4 'minimal nutrient concentration' = 600 [umol.g^{-1}]
2.4.14.11.5 'optimal nutrient concentration' = 1200 [umol.g^{-1}]
2.4.14.12 'number of xylem poles' = 6 [-]
2.4.14.13 'phosphorus' (Barber 1995)
2.4.14.13.1 ' Cmin' = 0.0002 [umol.ml^{-1}]
2.4.14.13.2 ' Imax' = 0.0555 [umol.cm^{-2}.day^{-1}]

2.4.14.13.3 ' Km' = 0.00545 [umol.ml^{-1}]
2.4.14.13.4 'minimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.14.13.5 'optimal nutrient concentration' = 60 [umol.g^{-1}]
2.4.14.14 'potassium' (Barber 1995)
2.4.14.14.1 ' CminImax' = 0.002 [umol.ml^{-1}]
2.4.14.14.2 ' Imax' = 0.467 [umol.cm^{-2}.day^{-1}]
2.4.14.14.3 ' Km' = 0.014 [umol.ml^{-1}]
2.4.14.14.4 'minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.14.14.5 'optimal nutrient concentration' = 234 [umol.g-1] (Silk et al. 1986)
2.4.14.15 'reduction in respiration due to aerenchyma' [100%]=f{'aerenchymaFormation'} [100%] x,y pairs :{0 0 0.3 0.7 0.6 1} (Fan et al. 2003)
2.4.14.16 'regular topology' = 1 [-]
2.4.14.17 'relative carbon cost of exudation' [g.cm^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 5e-06 100 5e-06} (Groleau-Renaud et al. 1998)
2.4.14.18 'relative respiration' [g.g^{-1}.day^{-1}]=f{'age'} [day] x,y pairs :{0 0.09 2 0.04 6 0.04 1000 0.04} (Fan et al., 2003)
2.4.14.19 'root class id' = 99 [-]
2.4.14.20 'root hair density' [#.cm^{-2}]=f{'age'} [day] x,y pairs :{0 2000 1 2000 2 2000 10 2000 30 0 2000 0} (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.14.21 'root hair diameter' = 0.0005 [cm]
2.4.14.22 'root hair length' [cm]=f{'age'} [day] x,y pairs :{0 0 1 0 2 0.028 2000 0.028} 2.4.15.20 (Zhu et al. 2005; Mackay & S. Barber 1985)
2.4.14.23 'soil impedence' = 0.02 [-]
2.4.14.24 'soil impedence.v2' [cm]=f{'uniform distribution'} minimum=-0.04 maximum=0.04
2.4.15 'shoot'
2.4.15.1 'area per plant' = 1600 [cm2]
2.4.15.2 'extinction coefficient' = 0.85 [-]
2.4.15.3 'leaf area expantion rate' [cm2.day^{-1}]=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} (Zhang and Postma, University Park, unpublished)
2.4.15.3.1 'multiplier' = 0.8 [-]
2.4.15.4 'light use efficiency' = 3.8e-07 [g.umol-1] (Stirling et al. 1994; Postma, University Park, unpublished)
2.4.15.5 'nitrate'
2.4.15.5.1 'leaf minimal nutrient concentration' [umol.g^{-1}]=f{'time'} [day] x,y pairs :{0 1200 80 800}
2.4.15.5.2 'leaf optimal nutrient concentration' [umol.g^{-1}]=f{'time'} [day] x,y pairs :{0 2500 80 1500} (Zhang and Postma, University Park, Unpublished; Alexandrova & Donov 2003; Chevalier & Schrader 1977)
2.4.15.5.3 'stem minimal nutrient concentration' = 400 [umol.g^{-1}]

2.4.15.5.4 'stem optimal nutrient concentration' = 800 [umol.g^{-1}]
2.4.15.6 'phosphorus'
2.4.15.6.1 'leaf minimal nutrient concentration' = 35 [umol.g^{-1}]
2.4.15.6.2 'leaf optimal nutrient concentration' = 70 [umol.g-1] (Zhang and Postma, University Park, unpublished)
2.4.15.6.3 'stem minimal nutrient concentration' = 15 [umol.g^{-1}]
2.4.15.6.4 'stem optimal nutrient concentration' = 30 [umol.g^{-1}]
2.4.15.7 'potassium'
2.4.15.7.1 'leaf minimal nutrient concentration' = 273 [umol.g^{-1}]
2.4.15.7.2 'leaf optimal nutrient concentration' = 508 [umol.g-1] (Leigh & Jones 1984)
2.4.15.7.3 'stem minimal nutrient concentration' = 117 [umol.g^{-1}]
2.4.15.7.4 'stem optimal nutrient concentration' = 250 [umol.g^{-1}]
2.4.15.8 'relative potential transpiration' = 100 [cm3.g-1] (Baldocchi 1994)
2.4.15.9 'relative respiration rate leafs' = 0.04 [g.g-1.day-1] (Postma, University Park, Unpublished)
2.4.15.10 'relative respiration rate stems' = 0.02 [g.g^{-1}.day^{-1}]
2.4.15.11 'specific leaf area' [g.cm^{-2}]=f{'time'} [day] x,y pairs :{0 0.0015 24 0.0026 50 0.0032 100 0.0032} (van Heemst 1988; Jacob & Lawlor 1991; Jaramillo, University Park, unpublished)
2.4.16 'stress impact factors'
2.4.16.1 'impact on:leaf area expantion rate'
2.4.16.1.1 'impact by:nitrate' [-]=f{'nitrate stress factor'} [-] x,y pairs :{0 0 0.3 0.1 1 1} (Sinclair & Horie 1989)
2.4.16.1.2 'impact by:phosphorus' [-]=f{'phosphorus stress factor'} [-] x,y pairs :{0 0 1 1} (Lynch et al. 1991; Usuda & Shimogawara 1991)
2.4.16.1.3 'impact by:potassium' [-]=f{'potassium stress factor'} [-] x,y pairs :{0 0 0.2 0.5 1 1}
2.4.16.2 'impact on:photosynthesis'
2.4.16.2.1 'impact by:nitrate' [-]=f{'nitrate stress factor'} [-] x,y pairs :{0 0 0.4 0.5 1 1} (Sinclair & Horie 1989)
2.4.16.2.2 'impact by:phosphorus' [-]=f{'phosphorus stress factor'} [-] x,y pairs :{0 0.5 0.5 1 1 1} (Lynch et al. 1991; Usuda & Shimogawara 1991)
2.4.16.2.3 'impact by:potassium' [-]=f{'potassium stress factor'} [-] x,y pairs :{0 0 1 1}

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Appendix C: Figures for comparing the Barber-Cushman model with SWMS3D

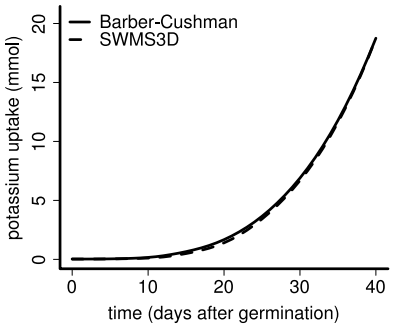

Figure 1: Potassium uptake by the maximum RCA reference genotype (Figure 4) simulated by the Barber-Cushman model and the SWMS3D model is near identical in high potassium soil (5.5 kg.ha^{-1} dissolved potassium in the soil solution).

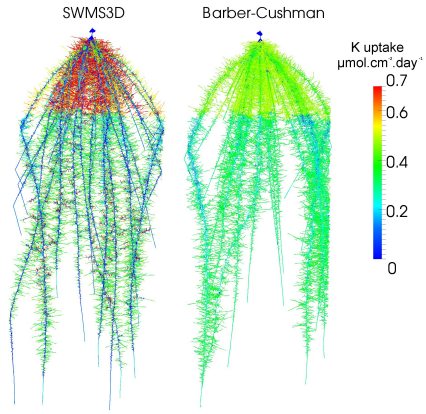

Figure 2: Visualization of potassium uptake rates in 40 day old maize plants using the SWMS3D model or the Barber-Cushman model. These are the same simulations for which the total uptake (over time) is plotted in figure 11. Roots are dilated (~2 times) for better visibility and thus do not show true root thickness.

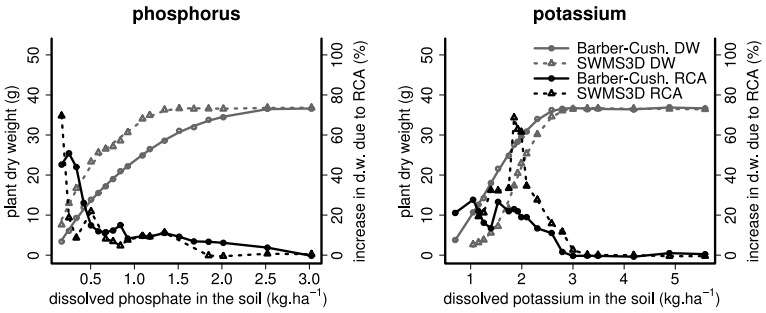

Figure 3: Dry weight response curves and RCA utility under different levels of phosphorus and potassium availability, simulated using the Barber-Cushman model or the SWMS3D model for phosphorus and potassium uptake. Grey lines show dry weight responds curves for non-RCA plants (left y-axis) while black lines show RCA utility (right y-axis).

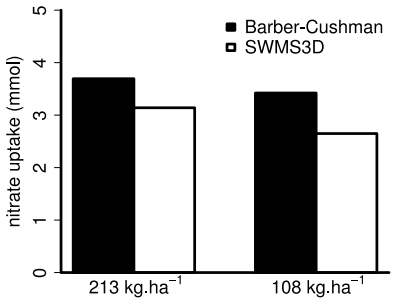

Figure 4: Comparison of simulation results for nitrate uptake by 18 day old maize plants as simulated by the SWMS3D and the Barber-Cushman model in soils with high (213 kg.ha^{-1}) and medium (108 kg.ha^{-1}) nitrate availability.