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CONCLUSIONS

Cation Type affect the uptake and assimilation of nitrate in barley.

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P2 - 2

Mechanistic models of nutrient uptake under predicts or over predicts to low concentrations? A correct uptake formula

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INTRODUCTION

Over the past four decades different mechanistic nutrient uptake models have been developed to simulate nutrient uptake. Two categories of models have evolved: steady state and transient models. The Barber-Cushman model is a well-known and widely-used model in this category. NUTRIENT UPTAKE model and NST 3.0 are the PC versions of the Barber-Cushman model which is solved numerically using the Crank-Nicholson and Newton-Ralphson techniques.

Under another approach, the methodology for solving moving boundary problems have been also applied to agronomic problems. Thus, there are previous papers in this area for which the nutrient uptake have been implicitly modeled as moving boundary problems, for example (Huguenin-Elie et al., 2003). An explicit moving boundary model applied to nutrient uptake were presented in Reginato et al., 2000, Jonard et al., 2010). In this presentation, the goal is to consider an improved version of our moving boundary model applied to uptake of ions of low, medium and high availability by roots. In particular, we will study and compare the uptake of ions through model NST 3.0 and our moving boundary model (NUT BI). For both models, we use a corrected new cumulative uptake formula.

METHODS

The one-dimensional moving boundary model is based on the same assumptions formulated by the Barber-Cushman model, but here, the model incorporates a new border condition for root competition which represents the net flux on the moving boundary (Reginato et al., 2000)

The solution of the moving boundary model is obtained by means of the integral balance method (Reginato et al., 1993). Thus, we obtain the concentration and the influx on the root surface as functions of time. In order to compute the cumulative nutrient uptake by the growing root system we use a simplified, correct and verified formula of our version (Reginato and Tarzia, 2002).

RESULTS AND DISCUSSION

Thus, for simulations of nutrient uptake we use two datasets extracted from literature. First, we compute the cumulative K, P and Mg uptake by pine seedling in pots during 180 days (Kelly, 1992) using the fixed boundary models (NST 3.0) and our moving boundary model (NUT BI). The results are shown on Table 1.

Table 1. K, P and Mg uptake by pine seedlings during 180 days

Uptake	K	P	Mg
	(µmol)	(µmol)	(µmol)
Observed	6663	1332	1617
Predicted NTS 3	6690	1320	683
Predicted NUT-BI	6629	1301	681
Peclet Number	0.00057	0.0041	0.1
Root Density (cm/cm3)		0.02 - 0.20	

Second, we compute P uptake for peanut with low, intermediate and high concentrations (increasing levels of P of 0, 50, 100, 200 and 400 mg/kg of soil) during 72 days (Singh, 2003). The results are shown on Table 2.

Table 2. P uptake by peanut during 72 days

Uptake	0 P	+50 P	+100 P	+ 200 P	+ 400 P
	(µmol)	(µmol)	(µmol)	(µmol)	(µmol)
Observed	540	640	900	1060	1320
Predicted NTS 3	708	3703	11855	32922	43841
Predicted NUT-BI	897	4680	8107	36789	43256
Peclet Number	0.022	0.027	0.025	0.029	0.03
Root Density (cm/cm^3)	0.96-3.17	1.06-3.54	1.20-3.97	1.08-3.68	0.80-2.72

From table 1, we conclude that for ions of low mobility such as P and K in soils with high concentrations and small Peclet numbers, plants with a small variation in root density give us similar predictions for the two models with low errors. However, in Table 2, for low concentrations, small Peclet number and a greater variation in root density, better predictions are obtained by the fixed boundary model. Although with increasing levels of concentrations in soil, both models overpredict with large errors. Since eleven input model parameters are affected by small errors and the propagation of errors committed by the numerical methods used for each physical model is small, the effectiveness of the physical model used is dependent on other physical factors as the Peclet number , variation in root density and the level of concentration of ions in the soil.

CONCLUSIONS

With the corrected absorption formula, both NTS 3 and NUT-BI models now over predict the nutrient uptake at low concentrations, yielding a different interpretation of the results with respect to those obtained by the model 3 NTS with the old formula that under predicting the uptake (Hinsinger, 2011). The accuracy of the predictions of different models is very important regarding the improvement of the effectiveness of the strategies of fertilization and decrease of reserves and production of P (Cordel et al., 2009). These results could change our understanding about the processes that occur in the rhizosphere.

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