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Title: Cumulative Uptake Formulas in Plant Nutrient and the Temporal Weight Averaged Influx

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Abstract: A generalized cumulative uptake formula of nutrient uptake by roots following our previous formula (Reginato and Tarzia, Commun. Soil Sci. Plant Anal., 33 (2002), 821-830) is developed. Cumulative nutrient uptake obtained by this formula is compared with the simulated results obtained by the Claassen-Barber (Claasen and Barber, Agron. J., 68 (1976) 961964) and Cushman (Cushman, Soil Sci. Soc. Am. J., 43 (1979) 1087-1090) formulas. A mass balance is analyzed for the three formulas of cumulative nutrient uptake in order to decide which of them is correct. Moreover, the mass balance is also verified through a computational algorithm using data obtained from literature and we compute the K uptake for maize for low and high soil concentrations using the three mentioned formulas. The theoretical analysis shows that Claassen-Barber and Cushman formulas do not verify, in general, the mass balance condition. The Claassen-Barber formula only verifies this condition when the influx is constant and root grows linearly. The Cushman formula verifies the mass balance when the influx is constant regardless of the law of root growth. Reginato-Tarzia formula always verifies the mass balance whatever be the representative functions for the influx and the law of root growth. Moreover, we propose a redefinition of the averaged influx from which the Williams formula can be deduced. We remark that Williams formula is a consequence of our definition of temporal weight averaged influx for all root growth law expressions. Also, we present a comparison of influx and cumulative uptake of Cd with data extracted from literature. Cumulative uptake is obtained through the Barber-Cushman model and our new moving boundary model by using the redefinition of averaged influx on root surface and the correct cumulative uptake formula presented in this paper.

This is a joint paper with Juan Carlos Reginato and Jorge Blengino Albrieu (Univ. Nacional de Río Cuarto), Río Cuarto, Argentina.