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The Potential Benefits for Controlled Release Phosphorus and Potassium in Specialty Agriculture

A. Amilcar Ubiera, PhD
Latin America-Everris

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Nutrient Sources

SOLUBILITY VS. AVAILABILITY

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Some Attributes of Conventional Fertilizers

Conventional NPK Fertilizers

- High and Immediate Dissolution, hence >>
- Total and Immediate Availability>>

However:

- Immediate exposure to direct losses or reduced availability over time.
- High Potential for 'Point Salinity' at Relatively High Rates

P and K Availability in Comparison to N

Losses of nitrogen

- Volatilization, NH_3
- Leaching, NO_3^-
- Denitrification, N_2O, N_2
- Immobilization, N org.
- Ammonification, NH_4^+

>>>**Environmental Impact**

Factors affecting availability

Phosphorus

- Adsorption-Precipitation>> **Fixation**

Potassium

- Adsorption-Precipitation>> **Fixation**
- Leaching

P and K availability related to:

- Intensity (Soil Solution)
- Quantity (Solid Phase)
- Buffer Capacity, Q/I

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Mechanisms Affecting P and K Availability

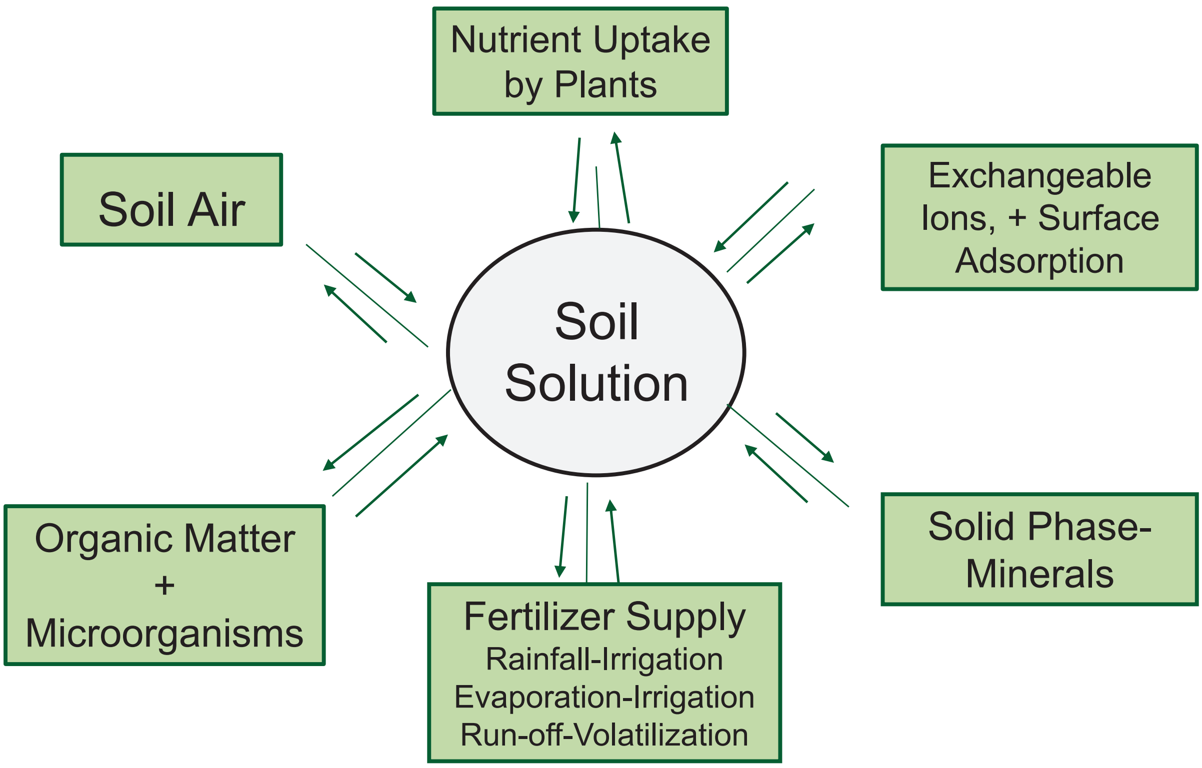
Phosphorus, $H_2PO_4^-$, HPO_4^{--}

- Specific Adsorption : *(surface adsorption on Fe-or Al-oxides-hydroxydes; amorphous Fe, Al materials, allophane-imogolite; kaolinite; low pH soils).*
- Precipitation Reactions *as Fe-P, Al-P and Ca-P (High pH-Calcareous soils) compounds*
- Occluded P with oxides
- Fixation
- Potential leaching only on extremely sandy soils

Potassium, K^+

- Exchange Reactions
- Specific adsorption
- Non-exchangeability
- Leaching in sandy soils and/or soils of very low ECEC (<<4 cmol(+) Kg^{-1})
- Fixation in soils rich in clays such as illite (hydrous micas), vermiculites, HC Smectites

Dynamic Equilibria in Soils



After Lindsay, W. L 1979

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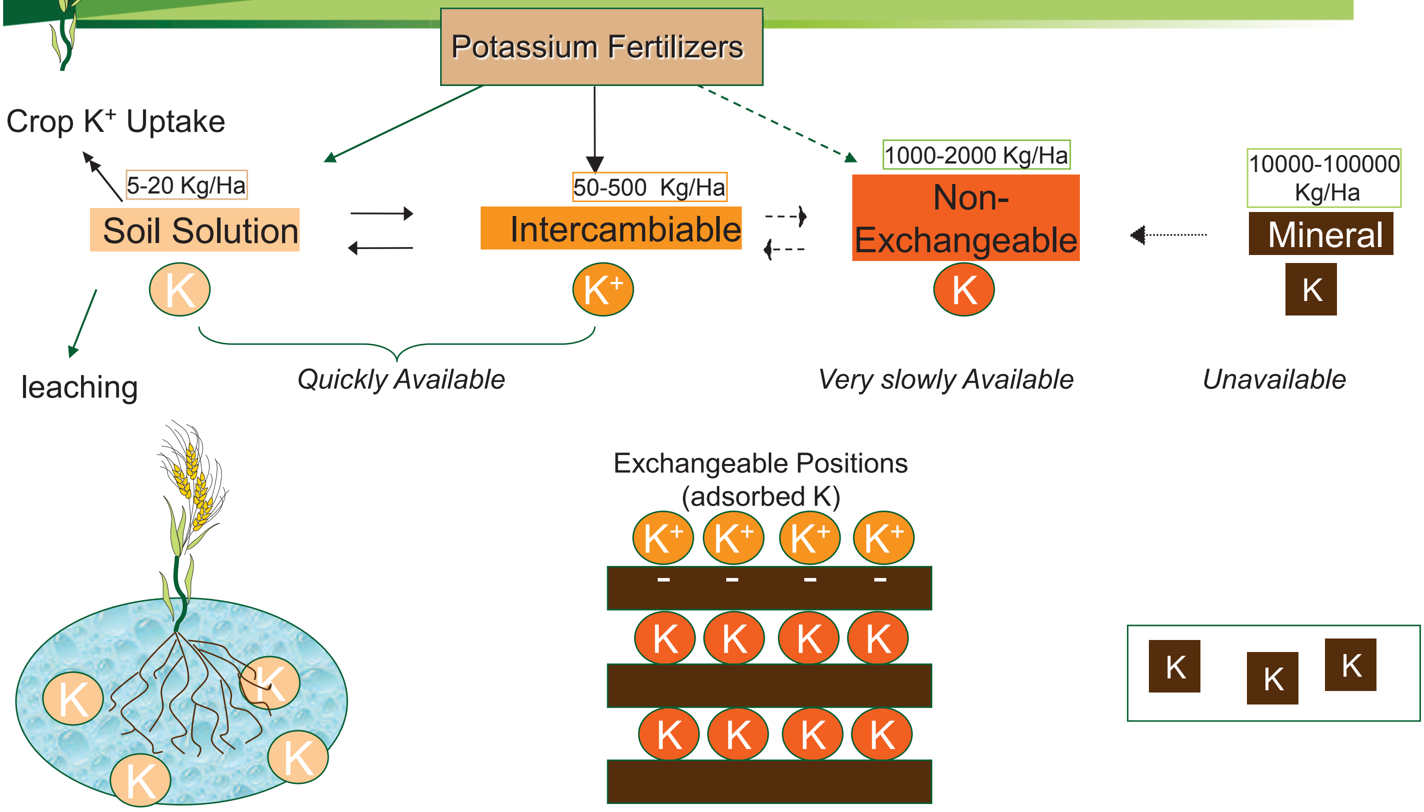
Potassium Dynamics in Soils



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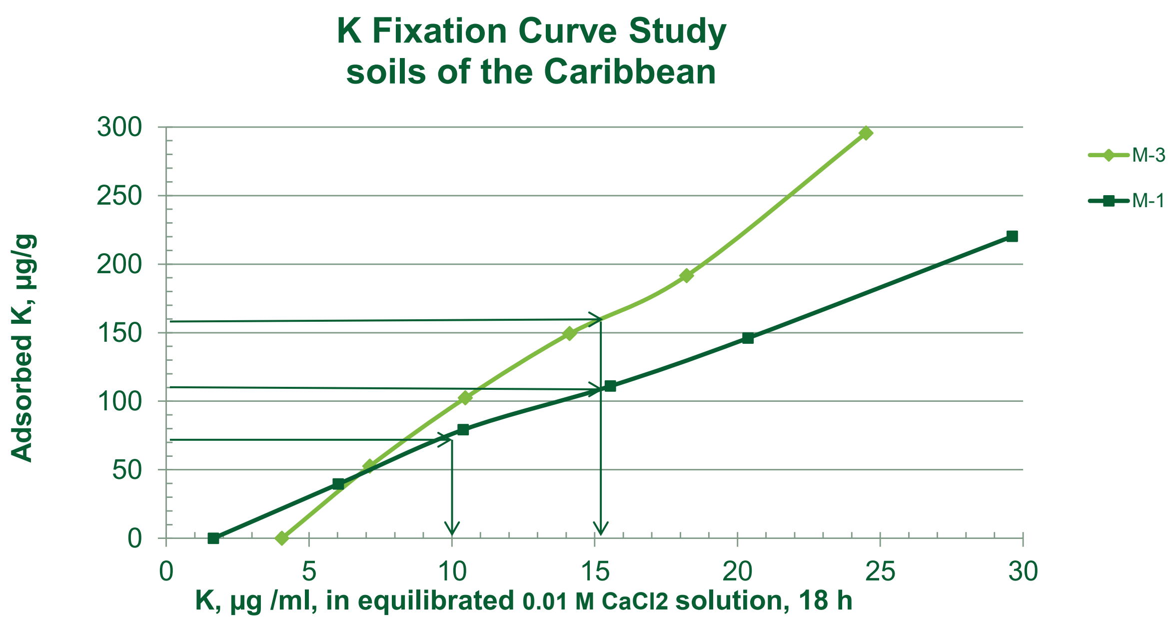
K Sorption Isotherms on Caribbean Soils



pH=6.2, Exch K=0.09 cmol (+)/Kg, OM=3.5 %, ECEC=15.9 Ksat%=0.56
pH=7.7, Exch K=0.35 cmol (+)/Kg, OM=3.2 %, ECEC=46.6 Ksat%=1.30

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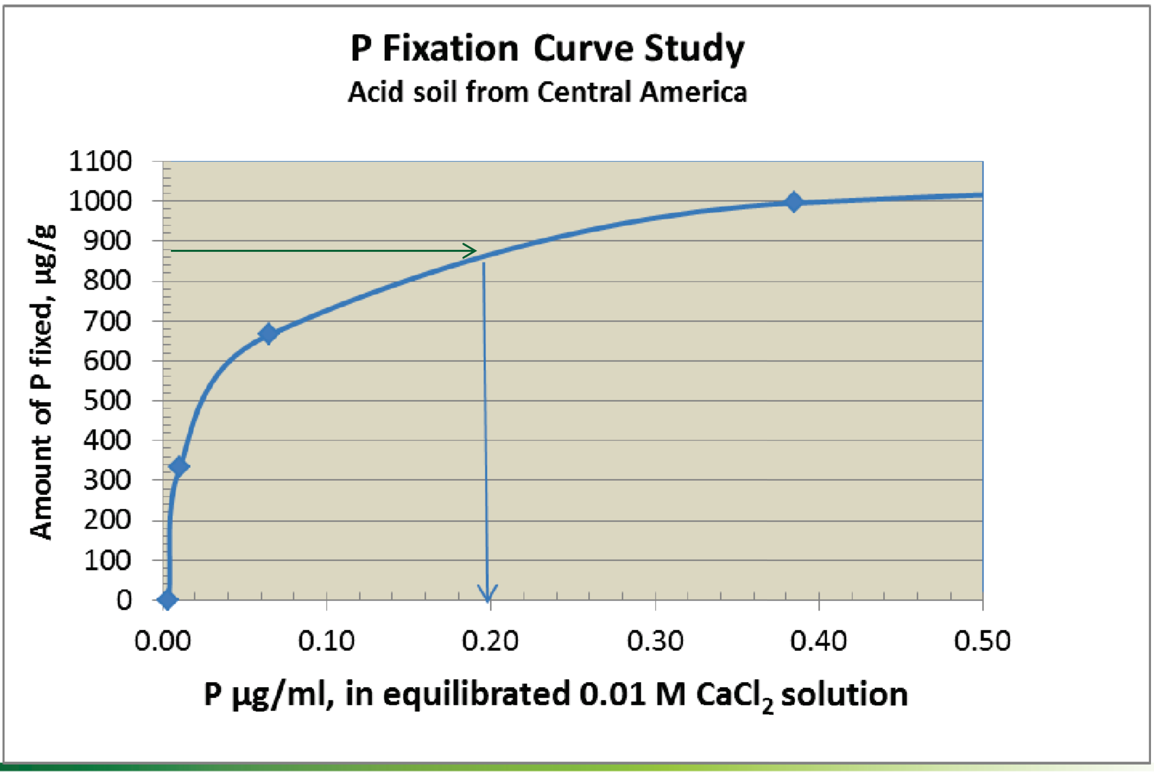
P Sorption Isotherm on an Acid Soil of Central America



pH=4.4 High Fe-OxHd, High Extr. Mn, Al

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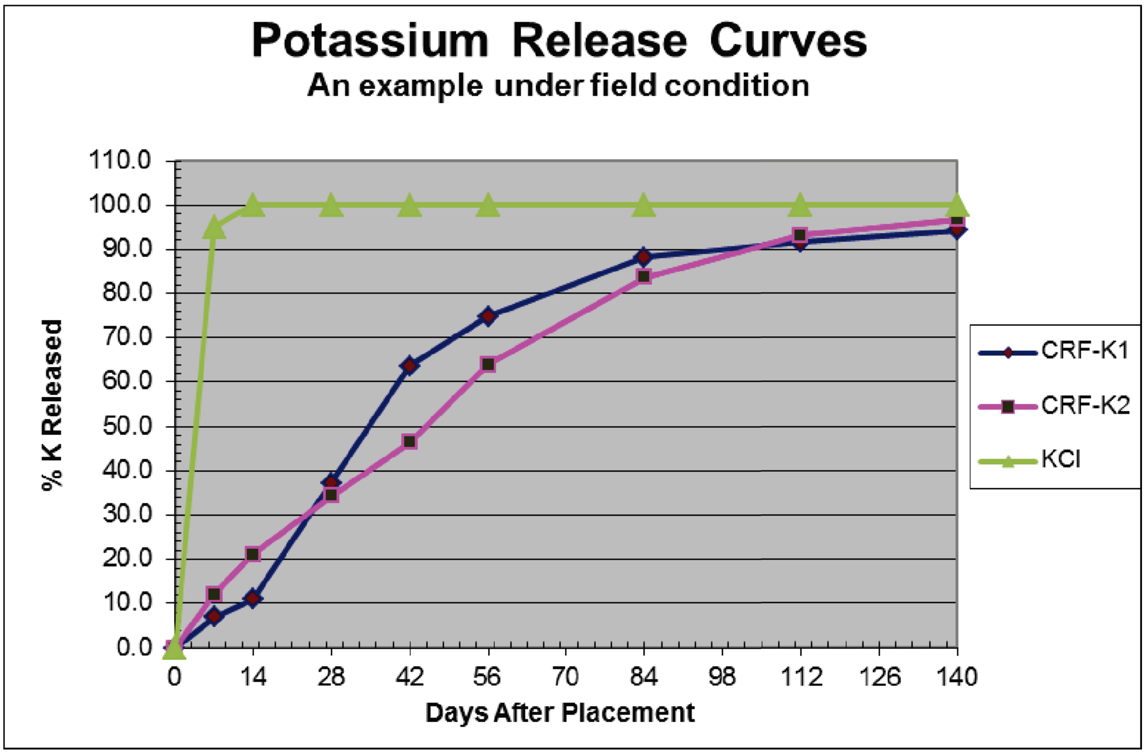
Evaluation of Coated K Release Under Field Condition



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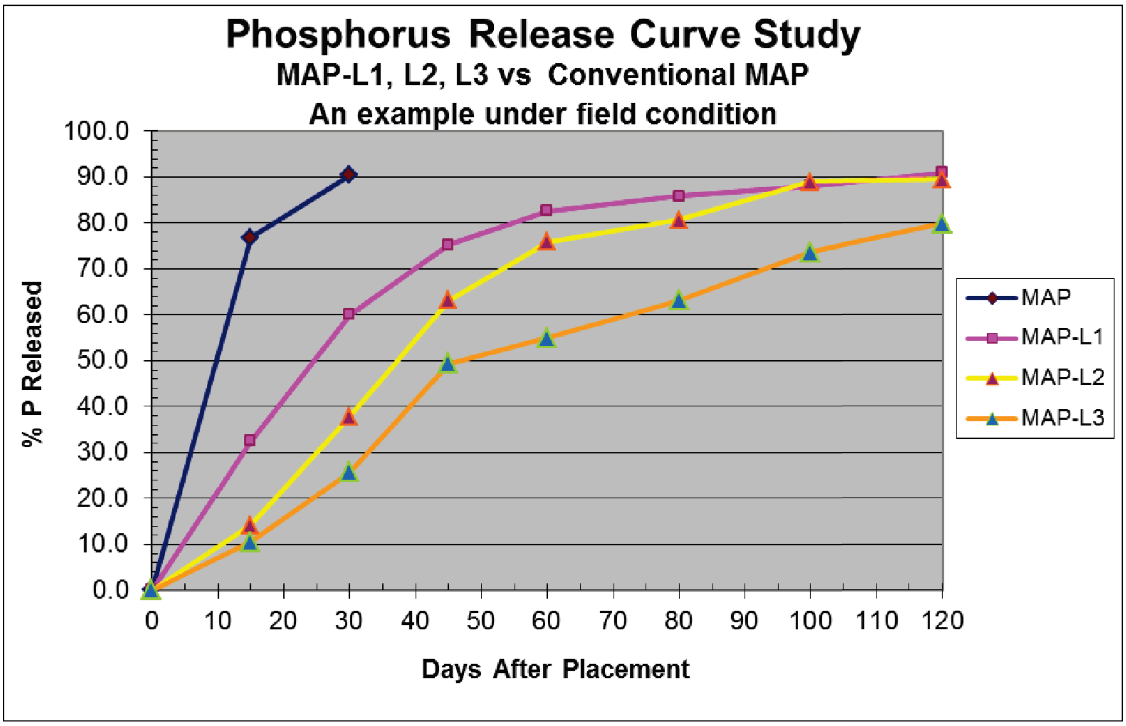
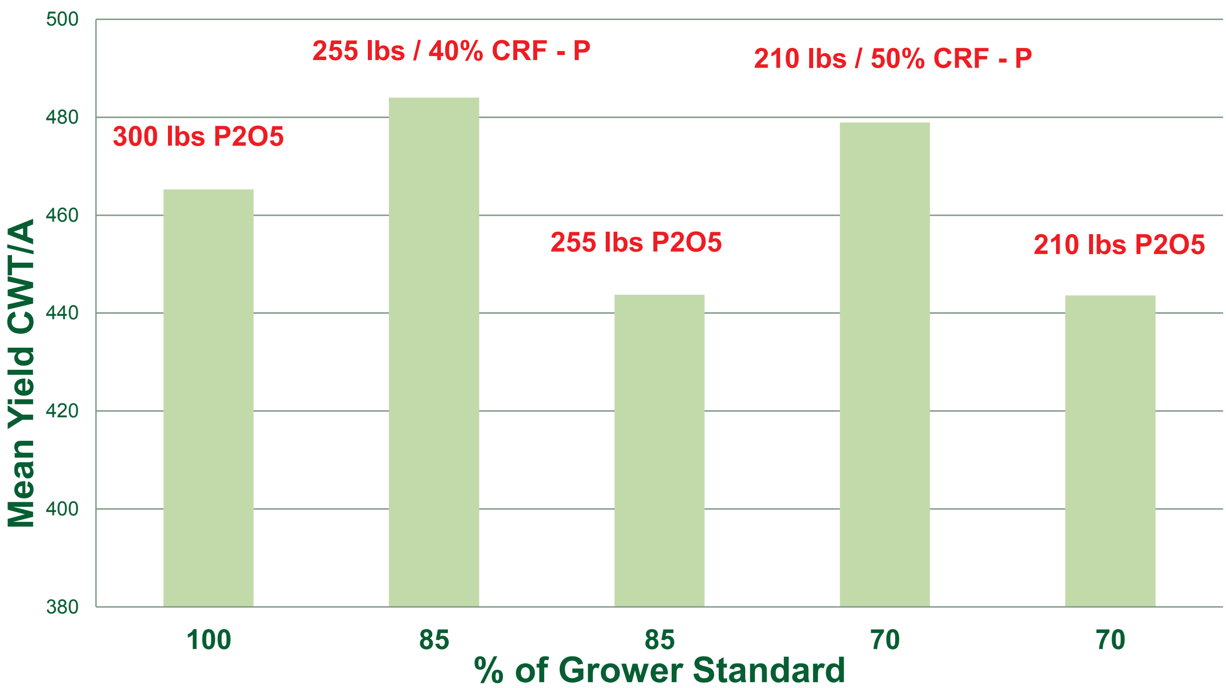
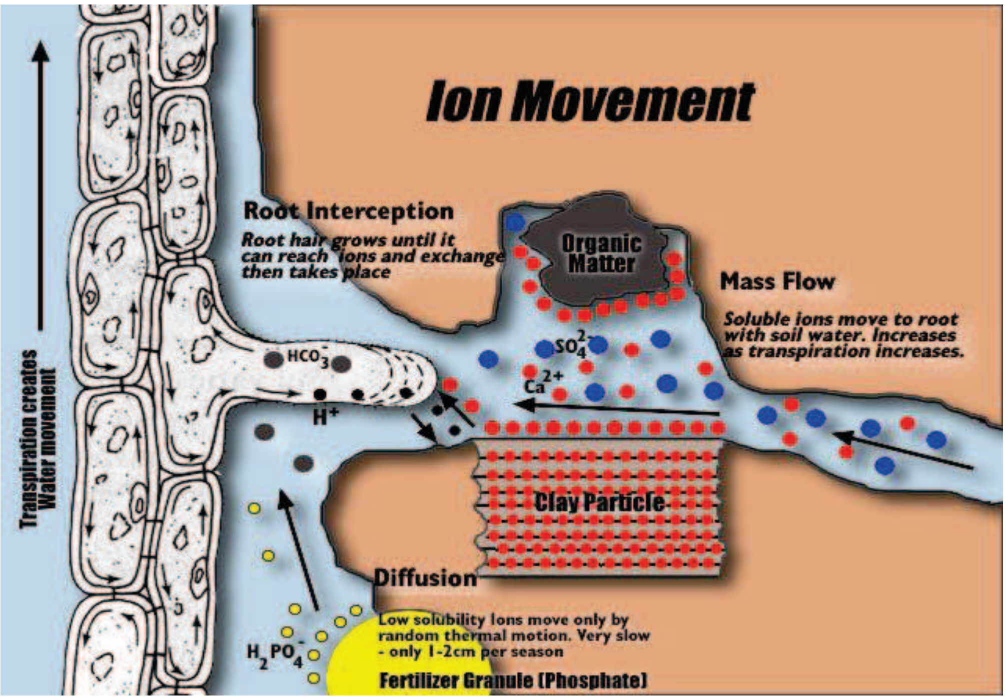
Evaluation of Coated P Release Under Field Condition



Effect of Coated MAP on Potato Yield Idaho 2011, Preliminary Evaluation



Nutrient Absorption and CRF



Nutrient Movement Mechanism

- **Mass Flow:** Ions move to roots as water flows via transpiration (ex. **Ca^{+2} , NO_3^-**)
- **Diffusion:** occurs by the concentration gradient from solution to root surface. (ex. **P, K)**
- **Interception-Root Elongation:** root hairs intercept ions with growth.
- **Mycorrhiza Assisted Uptake:** Fungus Symbiotic Association

Main Chemical Constraints in the Developing World

(includes tropical and subtropical regions, in million hectares)

Chemical Constraints	Latin America	Africa	South-South East Asia	Total
Low Nutrient Reserves	941	615	261	1817
Aluminum Toxicity	821	479	236	1536
High P Fixation by Fe Oxides	615	205	192	1012
High P Fixation by Allophanes-Imogolite	44	5	7	56
Low CEC	118	397	67	582
Calcareous Reactions	96	332	360	788

Source: Sanchez & Logan 1992, SSSA

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Optimizing the Use of P and K Through CRF

Soil conditions that favor CRF-P for higher efficiency

- High Fe-Al Oxy-hydroxides
- Amorphous Fe, Allophane-Imogolite-Organic Matter
- Small Size, Low Crystallinity Kaolinite
- High Exch. Acidity (Al, H)
- High pH soils (Calcareous)
- Potential Run-off
- Very Sandy Soils

Soil conditions that favor CRF-K for higher efficiency

- Very Sandy Soils
- Very low ECEC
- Highly K Fixing Clays (Vermiculite, illites, HC Smectites).
- Exch. Acidity (Al, H)
- Potential Run-off
- Medium to High Soil Salinity
- Localized or Banded High K rates (Management)

Young Banana Plantation in a High Rainfall Region of Tropics

rk

Band CRF-NK Application on a new Pineapple Field

Challenges Ahead for the EEF Sector

- CRF P and K have the potential to mimic the soil buffer capacity to control P and K ion in the soil solution to improve uptake efficiency (longevity, pattern of release, stability?)
- **Blends of CRF (P, K)** with **CONV (P, K)** could be more desirable or appropriate than CRF only. (What crops/Conditions?)
- Introducing CRF (P and K) technology into open field agriculture could save non-renewable natural resources, and reduced impact to the environment (Find the value equations and change grower culture?)

The extent to which the answers to these questions have been evolving during the last two decades is very encouraging for the agricultural sector but still much more work is warranted!


Muito Obrigado