AGRY 515 2014

- Nutrient Bioavailability
- Nutrient Movement in Soils
- Nutrient Concentrations in the Rhizosphere
Figure 1

Fig. 4–6. Diagram of a weathered mica particle containing about 50% expanded (vermiculite) layer. (a) “Frayed edge” and mica core; (b) alternate layers open half-way through interlayer; and (c) regularly interstratified mica–vermiculite (no wedge zones) (Rich, 1972).

Fig. 4–7. Proposed model of an expansible layer silicate with interlayers indicating effect on K fixation (Rich, 1968a).
Figure 2 (Fig. 12.12)

Soil solution concentration, "intensity" (chelators, soil pH, clay content ...)

Rate (reaction kinetics, temperature, microorganisms ...)

Quantity, capacity

"labile" "extractable"

"Nutrient availability" ("bioavailability")

- quantity (e.g., extractability)
- mobility, spatial availability
  - mass flow, diffusion
  - root growth, surface area, mycorrhizae
- root-induced changes in rhizosphere

Marschner, 1995
Figure 9.8
Processes affecting the relative concentration of different cations on exchange sites in temperate soils.
Figure 4

A diagram showing the pH levels across various nutrients:
- Nitrogen
- Phosphorus
- Potassium
- Sulfur
- Calcium
- Magnesium
- Iron
- Manganese
- Boron
- Copper
- Zinc
- Molybdenum

The pH scale ranges from 4.0 to 9.0, with labels for Acid, Neutral, and Alkaline.
Figure 5  What is soil buffer power?

**Figure 2.18** Relationship between K⁺ intensity and K⁺ quantity for two soils with different adsorbing capacities (Soil A high and Soil B low).

MENGEL & KIRKBY 1987

BARBER, 1995
Figure 7 (Fig. 12.1)

**FIGURE 12.1** Schematic presentation of the movement of elements to the root surface of soil-grown plants. (1) Root interception: soil volume displaced by roots. (2) Mass flow: transport of soil solution along the water potential gradient (driven by transpiration). (3) Diffusion: element transport along a concentration gradient. • = available nutrients (as determined, e.g. by soil testing).
Table 13.6
Plant Uptake and Estimates on Supply to the Roots by Mass Flow of Potassium, Magnesium, and Calcium in Spring Wheat and Sugar Beet Grown in a Silty Loam Soil (Luvisol Derived from Loess)\textsuperscript{a}

<table>
<thead>
<tr>
<th>Amount (kg ha\textsuperscript{-1})</th>
<th>Spring wheat</th>
<th>Sugar beet</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>Mg</td>
<td>Ca</td>
</tr>
<tr>
<td>Plant uptake</td>
<td>215</td>
<td>13</td>
</tr>
<tr>
<td>Mass flow</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>(% of total uptake)</td>
<td>(2)</td>
<td>(131)</td>
</tr>
</tbody>
</table>

\textsuperscript{a}From Strebel and Duynisveld (1989).

MARSCHNER, 1995
Table 13.7
Estimates of Diffusion Coefficients \((m^2 \text{ s}^{-1})\) of Ions in Water \((D_1)\) and in Soils \((D_e)\), and of Movement per Day at Average Values of \(D_e\)

<table>
<thead>
<tr>
<th>Ion</th>
<th>Water ((D_1))</th>
<th>Soil ((D_e))</th>
<th>Average (D_e) in soils</th>
<th>Movement in soils (mm per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{NO}_3^-)</td>
<td>(1.9 \times 10^{-9})</td>
<td>(10^{-10}-10^{-11})</td>
<td>(5 \times 10^{-11})</td>
<td>3.0</td>
</tr>
<tr>
<td>(K^+)</td>
<td>(2.0 \times 10^{-9})</td>
<td>(10^{-11}-10^{-12})</td>
<td>(5 \times 10^{-12})</td>
<td>0.9</td>
</tr>
<tr>
<td>(H_2\text{PO}_4^-)</td>
<td>(0.9 \times 10^{-9})</td>
<td>(10^{-12}-10^{-15})</td>
<td>(1 \times 10^{-13})</td>
<td>0.13</td>
</tr>
</tbody>
</table>

\(^a\)From Jungk (1991). Reprinted by courtesy of Marcel Dekker Inc.
Figure 8

- High nutrient level
- Depletion zones
- Low nutrient level

Nutrient concentration in the soil solution vs. Distance from the root surface.
Figure 12.2  Concentration gradient around roots of 7-day-old oilseed rape (Brassica napus) seedlings grown in a soil with different concentrations of exchangeable K. Modified from Kuchenbuch and Jungk (1984).
Figure 10 (Fig. 12.3)

**FIGURE 12.3** Concentration gradient of K in the soil solution around maize roots growing in soils with different clay contents. *Modified from Claassen and Jungk (1982).*
Figure 11 (Fig. 12.4)

FIGURE 12.4  Concentration of different K fractions in the rhizosphere of 7-day-old oilseed rape (Brassica napus) seedlings. From Jungk and Claassen (1986). Copyright Wiley-VCH Verlag GmbH & Co. KGaA. Reproduced with permission.