SOIL MANAGEMENT AND POTASSIUM AVAILABILITY

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THERE WERE NUMEROUS QUESTIONS IN 2000

- RELATED TO WEATHER?
  - DRY EARLY
  - HEAVY RAINS IN MAY AND JUNE
  - RELATIVELY COOLER SUMMER

- RELATED TO MANAGEMENT
  - NO-TILL AND HIGH RESIDUE FIELDS
  - MODERATE SOIL TEST K FIELDS
  - SOME FOLLOWING ALFALFA
K (Kalium) is a cation

- >90% of total K is unavailable
- <2% is readily available

Most available K on CEC

- Leaching an issue on sands and organic soils
- Movement on MTS & FTS small

Plant use affected by

- Movement to root surface
- Across root membrane
K FERTILIZATION AND LEACHING IN ANNUALLY TOPDRESSED ALFALFA

HANCOCK, WIS., 1979-1983
WOLKOWSKI AND KELLING
NUTRIENT MOVE TO ROOT SURFACE BY THREE MECHANISMS

- DIFFUSION
  - MOVEMENT FROM HIGHER TO LOWER CONCENTRATION
  - RANDOM MOVEMENT OF ATOMS
- MASS FLOW
  - MOVEMENT IN WATER BEING ABSORBED BY PLANTS
- ROOT INTERCEPTION
  - ROOT GROWS TO EXISTING ION
## Relative Importance of Nutrient Movement Mechanisms for a 150 bu/a Corn Crop

<table>
<thead>
<tr>
<th>NUT.</th>
<th>AMT. (lb/a)</th>
<th>ROOT INTERC.</th>
<th>MASS FLOW</th>
<th>DIFFUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>190</td>
<td>2</td>
<td>150</td>
<td>38</td>
</tr>
<tr>
<td>P</td>
<td>40</td>
<td>1</td>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td>K</td>
<td>195</td>
<td>4</td>
<td>35</td>
<td>156</td>
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</tbody>
</table>

_After Barber, 1884_
MOVEMENT ACROSS ROOT MEMBRANE

- PASSIVE vs. ACTIVE TRANSPORT
  - PASSIVE IS MOVEMENT DOWN AN ELECTROCHEMICAL GRADIENT
  - ACTIVE REQUIRES ENERGY BECAUSE TRANSPORT IS AGAINST EC GRADIENT

- K IS ABSORBED BY AN ACTIVE PROCESS
  - THE ONLY CATION ACTIVELY ABSORBED
  - ROOT RESPIRES
  - UTILIZES PHOTO-SYNTHATE AND NEEDS O$_2$
  - $<10\%$ O$_2$ REDUCES GROWTH
  - REDUCTIONS IN AIR-FILLED POROSITY WOULD REDUCE K UPTAKE
BULK DENSITY AND POROSITY

- **BULK DENSITY = MASS/VOLUME**
  - PARTICLE DENSITY: 2.65 g/cc
  - SAND: 1.5-1.6 g/cc
  - SILT LOAM: 1.2-1.3 g/cc

- **POROSITY:** $1 - \frac{D_b}{D_p}$
  - SAND: $1 - \frac{1.6}{2.65} = 0.40$
  - SILT LOAM: $1 - \frac{1.2}{2.65} = 0.55$

- **INCREASING BULK DENSITY REDUCES POROSITY**
## Compaction Effect on Porosity and Pore Size Distribution

<table>
<thead>
<tr>
<th>COMP.</th>
<th>DEPTH (in)</th>
<th>POROSITY (%)</th>
<th>L</th>
<th>M</th>
<th>S</th>
<th>VS</th>
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<tbody>
<tr>
<td>NO</td>
<td>1-4</td>
<td>53.4</td>
<td>27</td>
<td>7</td>
<td>36</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>6-9</td>
<td>52.5</td>
<td>24</td>
<td>5</td>
<td>39</td>
<td>32</td>
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<tr>
<td>YES</td>
<td>1-4</td>
<td>47.9</td>
<td>5</td>
<td>13</td>
<td>43</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>6-9</td>
<td>47.9</td>
<td>5</td>
<td>9</td>
<td>48</td>
<td>38</td>
</tr>
</tbody>
</table>

Compaction with 5 T Tractor, Tahla et al., 1979
POTASSIUM ACCUMULATES EARLY

ADAPTED FROM MENGEL AND KIRKBY, 1982
## BULK DENSITY EFFECT ON SOYBEAN

<table>
<thead>
<tr>
<th>BULK DENSITY</th>
<th>K ADDED</th>
<th>SHOOT WEIGHT</th>
<th>ROOT AREA</th>
<th>SHOOT K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ppm</td>
<td>oz/pot</td>
<td>sq in/pot</td>
<td>%</td>
</tr>
<tr>
<td>1.25</td>
<td>0</td>
<td>0.086</td>
<td>85</td>
<td>1.68</td>
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<tr>
<td></td>
<td>100</td>
<td>0.092</td>
<td>84</td>
<td>1.91</td>
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<tr>
<td>1.45</td>
<td>0</td>
<td>0.081</td>
<td>57</td>
<td>1.48</td>
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<tr>
<td></td>
<td>100</td>
<td>0.087</td>
<td>67</td>
<td>1.79</td>
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</tbody>
</table>

HALLMARK AND BARBER, 1981
# BULK DENSITY EFFECT ON CORN

<table>
<thead>
<tr>
<th>BULK DENSITY</th>
<th>KEWAUNEE</th>
<th></th>
<th>PLAINFIELD</th>
<th></th>
<th>PLANO</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LEAF K g/plt</td>
<td>ROOT mg/plt</td>
<td>LEAF K g/plt</td>
<td>ROOT mg/plt</td>
<td>LEAF K g/plt</td>
<td>ROOT mg/plt</td>
</tr>
<tr>
<td>INITIAL</td>
<td>1.12</td>
<td>39.6</td>
<td>0.72</td>
<td>32.0</td>
<td>1.00</td>
<td>42.3</td>
</tr>
<tr>
<td>X 1.25</td>
<td>0.98</td>
<td>35.7</td>
<td>0.60</td>
<td>30.8</td>
<td>0.92</td>
<td>39.2</td>
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</tbody>
</table>

WOLKOWSKI, 1990
INITIAL $D_b$: KEWAUNEE=1.17, PLAINFIELD=1.36, PLANO=0.88
RESPONSE OF CORN TO ROW K FERTILIZATION ON A COMPACTED SOIL

OSHKOSH, WIS. (WOLKOWSKI, 1989)
RESPONSE OF ALFALFA TO TOPDRESSED K FERTILIZER ON A COMPACTED SOIL

ARLINGTON, WIS. (WOLKOWSKI, 1992-1994)
RESPONSE OF ALFALFA TO SOIL TEST K ON A COMPACTED SOIL

ARLINGTON, WIS. (WOLKOWSKI, 1992-1994)
SUMMARY

- WEATHER LIKELY AFFECTED K UPTAKE
- WET MAY AND JUNE LIMITED ROOT DEVELOPMENT AND EARLY UPTAKE
- FACTORS THAT REDUCE AIR-FILLED POROSITY COULD CONTRIBUTE
- REDUCE COMPACTION AND PAY ATTENTION TO K FERTILITY