Enabling No-till Yields to Increase with Earthworms, Drainage

Malcolm Storey

Randy Schaetzl, http://geo.msu.edu/ extra/ geogmich /soil_drainage.html
Earthworms Create A Variety of Sizes of Conduits in the Soil

Worms provide the spectrum of pore sizes needed as conduits for optimum crop production.

Supply nutrients, hold water, prevent runoff
Continuous supply of water and oxygen and CO2
Protect plant from drowning or drying out.
Supply Channels Essential to High Yields Are Provided By the Earthworm Workforce

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Design and Function of:
Midden and Burrow Channel

A. Top view
- Crop residues
- embedded in earthworm excrement

B. Side view
- residue mat, bonded by excrement
- soil surface
- burrow 5mm diameter extending down to water table

\[ \approx 6'' \]
More About Deep, Stable Burrows

Active burrows may last ten years.

Worms use these burrows to survive and seek optimum food, moisture and temperature.

Burrows contribute to entry of water into soils

excavated burrow, pencil rests in burrow
No-till Management Increases or Maintains Worm Populations, Their Burrows & Vertical Water Movement

The frequency of soil penetration by burrows at this site is around six burrows per sq.ft. at one foot deep.

In no-till fields, worm populations counted by middens, are around 120,000/acre or 3/sq. ft.

Large occurrence of burrows in no-till rapidly moves rainfall to water table to depths up to 5 feet.
Earthworms Work Synergistically With No-till, to Increase Deeper Rooting & Water Available to Crops

Earthworm burrows serve as channels for roots to grow much deeper and thereby to recover deep stored water.

The no-till field absorbed practically all of the 38mm rainfall. This is 33% more, than water left in the soil of the tilled field.

Water recovered in the no-till field with deep rooted corn sustained rapid ear-filling several times faster than ear filling in tilled fields with shallower roots.
No-till, Earthworm Burrows and Deeper Rooting Increase Water Available to Crops

A. Tillage
- Soil Surface with No Worm Burrows
- Arrows indicate water entry into soil
- Depth of tillage
- Water content prior to rain
- Observed maximum depth of roots
- Water content after rain

B. No–Tillage
- Soil Surface with Worm Burrows
- Arrows indicate water entry
- Water content prior to rain
- Water content after rain
- Representation of night crawler burrow
- Maximum depth of roots

Water Content of the Soil (%) by Volume

Depth in Soil (feet)
No-till, Earthworm Burrows and Deeper Rooting Increase Water Available to Crops

Rainfall goes much deeper and faster into no-till soils.

33% more water enters the soil of the no-tilled field.

Water reachable by roots in no till fields, which have increased rooting depth within burrows, increased available water by an even higher %.
Crop Growth in No-till and Till Fields with Rain & Water Table Changes

Figure 9

A. Corn Stalk Height

B. Ear Circumference

C. Water Table Depth and Rainfall
No-till management led to more burrows and deeper rooting.

Deeper rooting in the no-till field accessed more subsoil water as indicated by the continued, greater decline in water table levels during the grain filling time.

Photosynthesis was sustained during August by water drawn from the subsoil.
Cob Circumference in No-till Fields Surpassed that in Tilled fields by mid-August

No-till fields produced Bigger Ears and Higher yield per acre.
Drainage in Fields Results in More Worm Burrow Development and Higher Yield.

Yield in the high land (with less topsoil and lower water tables) is higher than bottom land yield!

Tube drainage of the bottom land would probably increase yield from 85 to 220 bushels per acre.
Winter Survival Zone for Worm Populations Created By Lowering Water Table (Drainage)

The major threats to worm populations are flooding and freezing.

Drain tiles lower water table so topsoil and burrows are not repeatedly flooded.

Tiles also achieve a safer wintering zone between frostline and water table so worms avoid freezing.
Figure 14. Drainplow Systems Customize the Depth and Slope of Tile Lines to Match Contours of Field

Photo A Drainplow & Fouss

Photo B Drainplow at work.
When Gravity Disposal is Not Possible, Use a Sump Pump to Lift Drain Water to Gravity Ditch
Stand, Grain Weight per Ear and Yield Related to Tillage and Water Table Level

<table>
<thead>
<tr>
<th>Tillage/Water Table Level</th>
<th>No. in Stand</th>
<th>Grain Weight ac(^{-1})</th>
<th>Grain Weight ha(^{-1})</th>
<th>Yield Bu/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Till, Low W.T.</td>
<td>36,000</td>
<td>89,000</td>
<td>168</td>
<td>6.0</td>
</tr>
<tr>
<td>15.0</td>
<td>222</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Till, Medium W.T.</td>
<td>36,000</td>
<td>90,000</td>
<td>123</td>
<td>4.6</td>
</tr>
<tr>
<td>11.0</td>
<td>152</td>
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<td></td>
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</tr>
<tr>
<td>No-till, Low W.T.</td>
<td>28,000</td>
<td>69,000</td>
<td>224</td>
<td>8.0</td>
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<tr>
<td>15.5</td>
<td>230</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No-till, Med. W.T.</td>
<td>29,000</td>
<td>72,000</td>
<td>168</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Stands are greater in the Tilled field.

Weight/ear and per acre yield were higher in No-tilled field.