**Effect of loading time on soil structural failure**

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**Introduction**

While conceptually simple, the dynamics of soil compaction are quite complex. Soil compaction causes soil structural deformation and in the process of soil water potential changes, which can be used to identify the critical stress, the load causing structural failure. The objective of this study was to (1) identify soil organic matter (SOM) effects on loads required to create critical stress conditions and (2) identify the effect of SOM on loading time required to create critical stress conditions.

**Methods**

Soil samples were obtained from Northeast China, which is one of the most mechanized farming areas in China. This study involved a factorial combination of 4 variables: (1) applied stress (0, 0.1, 0.3, 0.5, 1, 2, 4, 8, and 11 kg/cm\(^2\)), (2) loading time (0, 0.1, 0.5, 1, 2.5, 5, 10, 50, 100, and 1800 s), (3) SOM content (8, 50, 80, 110 g/kg), and (4) soil water content (SWC) (11, 15, 19, and 24% g/g).

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**Results**

1. Soil water potential decreased with increasing applied stress. 4.52 kg/cm\(^2\) was the averaged critical stress (load corresponding to maximum absolute water potentials in Fig. 1) for all SWC when SOM was 8 g/kg. Critical stress was directly related to SOM content (data not shown).

2. Soil water potential decreased with time of load application up to 1800 seconds illustrating soil water dynamics associated with compaction forces (Fig. 2).

3. Loading time required to reach the critical stress condition decreased as SWC increased (Table 1 & Fig. 3b) and increased as SOM content increased (Fig. 3a).

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**Conclusion**

1. Critical stress was sensitive to SOM. Evidence suggests SOM increases critical stress for these soils further suggesting increasing SOM decreases compaction susceptibility.

2. As SOM increases, the time required to observe soil structure collapse increases for a given load, assuming that load exceeds the critical stress.

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**Table 1. Loading time corresponding to critical stress for soil with 8 g/kg of SOM and SWC of 11, 15, 19 and 24%**

<table>
<thead>
<tr>
<th>SWC (%)</th>
<th>Soil critical stress (kg/cm(^2))</th>
<th>Minimum soil potential (mbar)</th>
<th>Loading time (second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>4.76</td>
<td>-389.93</td>
<td>85.05</td>
</tr>
<tr>
<td>15</td>
<td>4.52</td>
<td>-334.54</td>
<td>76.57</td>
</tr>
<tr>
<td>19</td>
<td>4.47</td>
<td>-296.39</td>
<td>58.96</td>
</tr>
<tr>
<td>24</td>
<td>4.32</td>
<td>-259.21</td>
<td>54.62</td>
</tr>
</tbody>
</table>

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**Figure 1. Relationship between applied stress and soil water potential for soil with 8 g/kg of SOM and four different SWC (11, 15, 19, 24%).**