Soil aggregation and phosphorus availability following a one-time compost addition in semi-arid organic wheat systems

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Areas of semiarid to arid lands across the world

dry subhumid
semiarid
arid
hyperarid
Characteristics of semi-arid organic wheat soils

- Low soil fertility status
- Low soil organic carbon
- Lack of soil structure
- Low soil moisture due to lack of rainfall
- Phosphorus availability is limited due to high sorption and precipitation by soil surfaces and Fe, Al and Ca ions.
- There is a continues decrease in the concertation of available phosphorus
Compost effect on soil aggregates

- Formation of stable macroaggregates has significant impacts on belowground carbon and nutrient cycling
- Water infiltration and erosion
- Root growth and distribution
Fate of phosphorus in calcareous soils
Compost effect on phosphorus sorption and fixation

- Compost application decreases phosphorus sorption in calcareous soils (Khalid et al., 2011)
Objectives

Examines one-time compost effect on:

1. Soil aggregation.

2. Potential bioavailability of phosphorus.
**Methods**

- Compost applied at rates of 0, 25 and 50 Mg ha\(^{-1}\) in 2016
- 0-10 cm soil sampled in 2017

<table>
<thead>
<tr>
<th>Site Characteristics</th>
<th>Snowville</th>
<th>Blue Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>8.6</td>
<td>6.8</td>
</tr>
<tr>
<td>ECe (µs/cm)</td>
<td>195</td>
<td>84</td>
</tr>
<tr>
<td>CaCO(_3) (%)</td>
<td>18-28</td>
<td>0-20</td>
</tr>
<tr>
<td>Total annual precipitation (mm)</td>
<td>280</td>
<td>420</td>
</tr>
<tr>
<td>Mean Annual Temperature (°C)</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>
Soil aggregate separation

- Sieve 1 (4000 - 2000 µm)
- Sieve 2 (2000 - 1000 µm)
- Sieve 3 (1000 - 250 µm)
- Collecting pan (<250 µm)

Fresh soil

Plant residues and stones removed

Large macroaggregates
Small macroaggregates
Microaggregates

Sieved soil through 4000 µm sieve and cold dried at 4°C
Microbial release of organic phosphorus

4 g soil sample → 7 day incubation, 35 °C

Set A, unfumigated
0.5 M NaHCO₃ → Set B, fumigated

IP = Inorganic P
TP = Total P
OP = Organic P
MicP = Microbial P
Sequential phosphorus fractionation

1 g soil sample

50 ml 0.5 M NaHCO$_3$, 0.5 h → Labile P

50 ml 1 M HCl, 3 h → Moderately labile P

50 ml 0.5 M NaOH, 16 h → Stable P
Relative abundance of soil aggregates

Snowville

Blue Creek

Aggregate size class (mm)

Percentage (%)

Aggregate size class (mm)

Percentage (%)

0 Mg ha⁻¹

50 Mg ha⁻¹
Microbial release of organic phosphorus

Snowville: 216 % increase
Blue Creek: 61.2 % increase
Phosphorus bioavailability

**Snowville**

<table>
<thead>
<tr>
<th>Inorganic P concentration (mg kg(^{-1}))</th>
<th>Labile</th>
<th>Moderately labile</th>
<th>Stable</th>
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<tr>
<td>0</td>
<td>B</td>
<td>A, A</td>
<td>A, A</td>
</tr>
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**Blue Creek**

<table>
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<tr>
<th>Inorganic P concentration (mg kg(^{-1}))</th>
<th>Labile</th>
<th>Moderately labile</th>
<th>Stable</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Mg ha(^{-1})</td>
<td>B</td>
<td>A, A</td>
<td>A, A</td>
</tr>
<tr>
<td>25 Mg ha(^{-1})</td>
<td>B</td>
<td>A, A</td>
<td>A, A</td>
</tr>
<tr>
<td>50 Mg ha(^{-1})</td>
<td>B</td>
<td>A, A</td>
<td>A, A</td>
</tr>
</tbody>
</table>
Phosphorus bioavailability cont’d

Snowville

Organic P concentration (mg kg⁻¹)

Labile Moderately labile Stable

Blue Creek

Organic P concentration (mg kg⁻¹)

Labile Moderately labile Stable

Phosphorus bioavailability cont’d
Conclusions

• Compost had significant effect on aggregate formation at Snowville but not at Blue Creek

• Compost had greater effect on P bioavailability in Snowville than in Blue Creek