Nitrogen Release and Carbon Loss from Soil Organic Matter During Decomposition of Added Plant Residues

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Soil organic matter is either relatively resistant to microbial attack or is somehow made unavailable during the course of the decomposition process. By means of recently developed tracer techniques it has been shown that the latter is probable the case, but that the low availability of soil organic matter is more apparent than real. In the decomposition of organic material enriched with the N\textsuperscript{15} isotope, it was found that in the presence of available energy materials the susceptibility to mineralization of nitrogen in the soil organic fraction was enhanced. Moreover, Sudan grass enriched with C\textsuperscript{14} added to soil greatly accelerated the decomposition of organic matter already present. Both these phenomena were attributed to increased microbial activity brought about by the addition to the soil of considerable energy material (2, 4).

In 1926, Lohnis (3) found evidence that green manures render the soil nitrogen more available. In greenhouse pot experiments he was able to recover in some instances more nitrogen than was added to the pots as green manure.

These experiments might well explain why green manuring has seldom resulted in permanent increases in soil organic matter. Since the intensified microbial activity resulting from the addition of readily decomposable plant residues has caused, under certain conditions, an acceleration in the mineralization of nitrogen and carbon in the soil organic matter, the practice of green manuring needs re-evaluation and the principles involved should be further investigated.

The experiments reported here were designed to investigate further some of the effects of young, high-nitrogen plant residues on carbon and nitrogen transformations in soil.

DECOMPOSITION OF READILY AVAILABLE ENERGY MATERIALS

Ten-gram samples of Marshall silt loam containing 1.61% organic carbon were weighed into 50-ml Erlenmeyer flasks. One set of flasks received no organic additions; a second set received 100 mg of sucrose, and a third set received 100 mg of corn stalk cellulose. Half of the flasks received 20 mg of potassium nitrate. Sufficient water was added to bring the soil in each flask to 75% of moisture capacity, and the flasks were then allowed to incubate for 67 days. Accurate dry weight determinations were made before and after incubation and the organic matter loss obtained by difference.

A similar experiment was performed with soil, Clarion silt loam, containing 1.28% organic carbon. In this experiment 20 mg of potassium nitrate were added to all flasks, and one set of flasks were decomposed alone and in an equal mixture of 50 mg of sucrose plus 50 mg of cellulose. Incubation was for only 30 days in this case.

A third experiment was carried out in the absence of soil. Two-gram samples of ground plant residues were placed in small flasks, brought to optimal moisture, and allowed to incubate at room temperature for 23 days. Mature corn stalks and young sweetclover were decomposed alone and in an equal mixture and it was ascertained whether the more available material, sweetclover, would affect the rate of decomposition of corn stalks. Since the nitrogen content of sweetclover stalks was only 0.71% as compared with 2.6% in the sweetclover, sufficient nitrate was added to 50 mg of flasks containing corn stalks to bring the nitrogen content to 1.4%. The data obtained from these experiments are shown in Tables 1, 2, and 3.

<table>
<thead>
<tr>
<th>Soil treatment</th>
<th>Weight loss over check, mg</th>
<th>Weight loss as % of added organic matter</th>
<th>Carbon loss over check, mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil + 100 mg sucrose</td>
<td>87.5</td>
<td>87.0</td>
<td>37.9</td>
</tr>
<tr>
<td>Soil + 100 mg sucrose + 20 mg KNO(_3)</td>
<td>104.1</td>
<td>103.6</td>
<td>42.8</td>
</tr>
<tr>
<td>Soil + 100 mg cellulose</td>
<td>59.3</td>
<td>63.8</td>
<td>23.7</td>
</tr>
<tr>
<td>Soil + 100 mg cellulose + 20 mg KNO(_3)</td>
<td>81.9</td>
<td>88.5</td>
<td>32.1</td>
</tr>
</tbody>
</table>

*All figures are the average of four replicates.

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</thead>
<tbody>
<tr>
<td>Soil + 100 mg sucrose</td>
<td>98.1</td>
<td>94.1</td>
<td>35.8</td>
</tr>
<tr>
<td>Soil + 50 mg sucrose + 50 mg cellulose</td>
<td>96.0</td>
<td>98.3</td>
<td>29.6</td>
</tr>
<tr>
<td>Soil + 100 mg cellulose</td>
<td>82.0</td>
<td>82.4</td>
<td>23.1</td>
</tr>
</tbody>
</table>

Least significant diff.