UREA HYDROLYSIS IN SOME TEA SOILS

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Key words
Polyphenols Tea soils Urea

Summary

The rate of conversion of urea to ammonium was studied in some acid tea soils of Sri Lanka. The stable levels of urease present in these soils are adequate to hydrolyse the applied urea. There was rapid and almost complete conversion of urea to ammonium and the rate of hydrolysis was independent of soil moisture at 25 per cent and above. The rate of conversion of urea to ammonium depended on the soil polyphenol concentration and had no relationship with either the organic carbon content or the texture.

Introduction

Sulphate of ammonia has been widely used as the main source of nitrogenous fertilizer for tea cultivation in Sri Lanka up to 1965. The continuous use of high rates of ammonium sulphate (200-300 kg N ha⁻¹ annum⁻¹) has resulted in tea soils becoming very acidic (pH 3.5-4.5). Urea is now being increasingly used as an alternative source of nitrogen because of its high nitrogen content coupled with the low cost per unit of N and less soil acidifying properties when compared with sulphate of ammonia.

It is well established that the conversion of urea to ammonium in soil is brought about by the enzyme urease. Although considerable information is available on urea reaction in tropical and temperate soils little is known of the rates of urea hydrolysis in tea soils. The investigations of these authors were based on a buffer method. However the buffer method does not represent the true ability of soils to hydrolyze fertilizer urea. Since there is a paucity of information on the fate of applied urea in tea soils an attempt has been made to investigate urea transformations in tea soils by direct estimation of urea in the absence of any buffers.

Materials and methods

Surface soil (0-15 cm) used in these experiments were sampled from four different tea growing districts. Some physical and chemical properties of these soils are given in Table 1. Before use, each sample was air dried and screened through a 2 mm sieve and the analysis reported in Table 1.
Table 1. Description of the tea soils

<table>
<thead>
<tr>
<th>Sampling depth and location</th>
<th>Soil texture*</th>
<th>Total N (%)</th>
<th>Org. C (%)</th>
<th>pH in 2 N KCl</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 0-15 cm St Coombs (1500 m amsl.)</td>
<td>Clay 39.6 Silt 23.2 Sand 37.2</td>
<td>0.18</td>
<td>2.64</td>
<td>4.1</td>
</tr>
<tr>
<td>B. 0-15 cm Passara (800 m amsl.)</td>
<td>Clay 26.8 Silt 14.2 Sand 59.0</td>
<td>0.17</td>
<td>2.30</td>
<td>4.0</td>
</tr>
<tr>
<td>C. 0-15 cm Hantane (1000 m amsl.)</td>
<td>Clay 37.6 Silt 10.6 Sand 51.8</td>
<td>0.12</td>
<td>1.42</td>
<td>4.1</td>
</tr>
<tr>
<td>D. 0-15 cm Ratnapura (500 m amsl.)</td>
<td>Clay 28.9 Silt 6.4 Sand 64.7</td>
<td>0.11</td>
<td>1.35</td>
<td>4.5</td>
</tr>
</tbody>
</table>

* Per cent of oven dry soil (105°C).

Urea hydrolysis to ammonia was measured at five moisture regimes (15, 20, 25, 30 and 40 per cent) ranging from permanent wilting point to field capacity.

The rates of urea hydrolysis in the above soils were determined by the following procedure. Air dry soil equivalent to ten g oven-dry soil was treated in 125 ml wide-mouth bottles with one ml of urea solution containing 1000 μg urea N and their water contents adjusted from 15–40 per cent by the addition of distilled water. Each bottle was stoppered with a cork fitted with a glass tube in which a rolled filter paper saturated with 0.5 N H₂SO₄ was placed to absorb any gaseous ammonia formed during the incubation period. All incubations were carried out in duplicate at 22°C under aerobic conditions for seven days and the extent of urea hydrolysis determined by analysing for unreacted urea and ammonia produced. To estimate the rate of conversion of urea to ammonium the incubated samples were shaken with 100 ml of 2 M KCl containing 5 μg ml⁻¹ phenyl mercuric acetate for 30 minutes at 3 to 6 hour intervals depending on the rate of hydrolysis. The resulting soil suspension was filtered and analysed for urea-N⁴, NH₄⁺-N⁴ and pH. Gaseous ammonia losses were estimated by shaking the filter paper with 50 ml 2 N KCl for 30 minutes and analysing the NH₄⁺-N⁴. Duplicate samples of soil which received no urea were also included in order to distinguish the ammonia derived from other sources.

Results and discussion

The conversion of urea to ammonium N in the four soils (A, B, C and D) during a seven day incubation period at 30 per cent soil moisture is shown in Fig. 1. In soils (C) and (D) 1000 μg urea-N was converted to NH₄⁺-N within 20 hours at all soil moisture contents above 20 per cent and at 22°C indicating very high urease activity in these two soils. Soils (A) and (B) took a relatively longer time to hydrolyse the urea but again the rate of hydrolysis was independent of the soil moisture above 20 per cent. The conversion was