The Priming Effect of Glucose in Soil Sterilized by γ-Radiation and Reinoculated with *Cellulomonas* sp.*

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**ABSTRACT.** Mineralization of native organic matter and \(^{14}\text{C}\)-glucose was followed by measuring the formation of \(\text{CO}_2\) and its radioactivity in chernozem soil samples presterilized by γ-radiation and inoculated with a washed suspension of *Cellulomonas* sp. cells. The introduced bacteria mineralized the soil organic component to a higher extent in variants enriched with glucose. This so-called priming effect of glucose was observed also in the presence of chloramphenicol, inhibiting the growth of the bacteria. The increased mineralization of the native soil organic fraction was also detected in samples that were not enriched with glucose when the bacterial suspension was first disintegrated ultrasonically and the material then used for the inoculation. Possible participation of phenomena of the type of cometabolism and activation of cell membrane transport mechanisms on the occurrence of the priming effect of glucose in the soil is discussed.

Stimulation of decomposition of aromatic compounds, fulvic acids and humic acids by bacteria in soil and in pure cultures in the presence of glucose could be demonstrated previously (Kunc and Macura 1966; Kunc 1971, 1974a; Kunc and Kotyk 1974; Kunc et al. 1976; Gordienko and Kunc 1977). As the above compounds represent important components of soil organic matter a possible association of the facts described with the so-called priming effect of glucose in the soil can be considered. This phenomenon was observed by a number of authors (e.g. Bingeman et al. 1953; Jansson 1960; Macura et al. 1965) and is characterized by a changed mineralization of native organic matter in soil enriched with glucose. The priming effect can be investigated only with the aid of isotopically labelled compounds, in order to determine the origin of carbon dioxide produced. In spite of the fact that a considerable amount of data concerning the priming effect accumulated (Jenkinson 1966) the mechanisms leading to its occurrence have not yet been sufficiently clarified. The positive priming effect, when mineralization of the native organic fraction in soil is stimulated due to addition of glucose, is undoubtedly associated with increased growth of the soil microflora (Parnas 1976). However, when an analogy between the priming effect and certain previous findings (Kunc 1974b) is admitted, it can be considered that consequences of multiplication of microorganisms are probably not the only possible mechanism of the occurrence of the priming effect.

It was the aim of the present communication to obtain more detailed data concerning some phenomena associated with the priming effect and manifested at the

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* Dedicated to the memory of Dr. J. Macura, DrSc.
TABLE I. CO₂ production during a 1-d incubation of a washed suspension of cells of *Cellulomonas* sp. in 25 g of the structural γ-sterilized soil in the presence and absence of U¹⁴-glucose

<table>
<thead>
<tr>
<th>Released CO₂-C, mg</th>
<th>0—6</th>
<th>6—12</th>
<th>12—18</th>
<th>18—24</th>
<th>0—24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>C</td>
<td>G</td>
<td>C</td>
<td>G</td>
<td>C</td>
</tr>
<tr>
<td>From ¹⁴C-Glucose</td>
<td></td>
<td>6.6</td>
<td>0.3</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>From unlabelled sources</td>
<td>1.6</td>
<td>3.9</td>
<td>1.0</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Priming effect</td>
<td></td>
<td>2.3</td>
<td>0.9</td>
<td>0.2</td>
<td>0.1</td>
</tr>
</tbody>
</table>

* The initial amount of glucose corresponded to 2.0 mg carbon, dry mass of bacteria added at the beginning of the experiment was 84.7 mg; b C not supplemented, G glucose added.

cellular and subcellular level directly in the soil. Therefore, an experimental model soil system was selected, in which the native microflora was eliminated by γ-radiation. The sterile soil was enriched with radioactive glucose and reinoculated with *Cellulomonas*.

MATERIALS AND METHODS

*Soil.* Samples of the chernozem soil (Libeznice) were taken from the surface layer of the arable soil (0—150 mm). The soil contained 2.09% carbon, 0.23% nitrogen, C : N ratio was 9.3, the pH of its aqueous suspension (1 : 2.5) was 7.6. The soil water-holding capacity was 48.5%. Air dried soil was sieved; the fraction of structural aggregates of 2—5 mm was used. Samples of 25 g of soil placed in double polyethylene bags (75 × 150 mm) were irradiated with γ-rays (¹⁰⁰Co source, 45 kGy) at the Institute for Nuclear Research, Czechoslovak Academy of Sciences. The treated samples were practically sterile (Kunc 1974a); for further use they were stored in a refrigerator.

*Bacteria.* The bacterial strain V 9 was isolated from the chernozem soil and identified according to Bergey (1957) as a species of *Cellulomonas*. The strain was subcultured in tubes with an agar mineral medium (Taylor 1951) with 0.5% vanillin as the only carbon source and maintained in a refrigerator. Bacterial suspension in 66 mM phosphate buffer (pH 7) was prepared from cultures grown for 44—48 h in meat-peptone broth (Oxoid Standard Bouillon CM 219) on a shaker at 28 °C and washed three times with physiological saline. This suspension was used in the experiments.

Growth of the bacteria was determined nephelometrically (De Bonet Maury et Jouan, Paris) at 34 °C in 10 ml of the mineral medium (Taylor 1951), in which the level of phosphates was adjusted in such a way as to correspond to 66 mM buffer (pH 7.2) and in which glucose served as the only carbon source (0.15%).

Counts of bacteria in the soil were determined by the dilution plate technique after a 7-d cultivation on agar plates containing yeast and soil extract and tryptone (Taylor 1951).

The MSE Model D ultrasonic disintegrator was used to sonicate the cells. Sonication was done for 10 min at the maximum frequency and with simultaneous cooling with ice.