Available online at www.sciencedirect.com
SCIENCE DIRECT
ELSEVIER
Journal of Environmental Radioactivity 83 (2005) 199–211
JOURNAL OF ENVIRONMENTAL RADIOACTIVITY
www.elsevier.com/locate/jenvrad

Soil-to-plant transfer of radiocaesium for selected tropical plant species in Bangladesh

M.M. Rahman [a,*], M.M. Rahman [b], A. Koddus [b], G.U. Ahmad [c], G. Voigt [a]

[a] *International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box No. 200, A-1400 Vienna, Austria*
[b] *Institute of Nuclear Science and Technology, Atomic Energy Research Establishment, GPO Box No. 3787, Dhaka-1000, Bangladesh*
[c] *Department of Physics, Bangladesh University of Engineering and Technology, Dhaka-1000, Bangladesh*

Received 26 August 2004; received in revised form 8 February 2005; accepted 24 March 2005
Available online 31 May 2005

Abstract

Soil-to-plant transfer factors (TF) of radiocaesium (^{137}Cs) were determined under field condition for grassy vegetation grown in Bangladesh at contaminated land in the Atomic Energy Research Establishment (AERE) campus. TF values for rice, grass and grassy/root vegetations grown in the same type of soil were also measured under pot condition. TF values of ^{137}Cs for grassy vegetation (2.4×10^{-2}–4.2×10^{-2} with an average of $3.1 \times 10^{-2} \pm 0.005$) obtained under field condition were slightly lower than the values for grass and grassy/root vegetations (2.9×10^{-2}–6.6×10^{-2} with an average of $4.8 \times 10^{-2} \pm 0.01$ for grass and grassy vegetations and 2.3×10^{-2}–5.6×10^{-2} with an average of $4.0 \times 10^{-2} \pm 0.009$ for root vegetations, respectively) obtained under pot condition. However, TF values (9.0×10^{-3}–2.6×10^{-2} with an average of $1.9 \times 10^{-2} \pm 0.004$) obtained for rice were about a factor of 4 lower than the values obtained for grass and grassy/root vegetations. When the properties of the AERE soils as input parameters were used in the soil–plant transfer model of Absalom, the estimated TF values (4.5×10^{-2}–6.7×10^{-2} with an average of $5.3 \times 10^{-2} \pm 0.006$) were

* Corresponding author. Tel.: +43 1 2600 26115; fax: +43 1 2600 29564.
E-mail address: mazibur.rahman@iaea.org (M.M. Rahman).

0265-931X/$ - see front matter
doi:10.1016/j.jenvrad.2005.03.004

consistent with the measured values obtained for grass and grassy vegetations under pot condition, however, the model overestimates the TF values for rice.

Keywords: Soil properties; Transfer model; Radiocaesium; Soil-to-plant transfer; Tropical environment

1. Introduction

A human being's well-being depends largely on a healthy surrounding environmental media, both abiotic and biotic. In fact, the environmental media are being stressed among others by a variety of man-made developed technological and chemical agents. One of those is the application of ionizing radiation in agriculture, medicine, industry, research and development, because exposure to ionizing radiation will impact health even though dose effect relationships and thresholds are still under discussion. Radionuclides produced by nuclear explosion and nuclear facilities have the potential to release into the atmosphere. These nuclides are part of the fallout, which are deposited and reach human body via the food chain (Eisenbud, 1973). Of major concern is radiocaesium (^{137}Cs) as a long-lived fission product with a high mobility in the soil–plant system, a long-term bioavailability, and high transfer rates into human food thus resulting in long-term internal and external radiation exposures of man. Large-scale releases of ^{137}Cs in the environment affect agro-ecosystems and food production, and consequently accumulate in the soil–plant system potentially for many years. The plant uptake of ^{137}Cs from soil, often is expressed as transfer factor (TF), which may vary significantly depending upon mainly soil type, pH, solid/liquid distribution coefficient, exchangeable K^+ and organic matter content (Cremers et al., 1988). It is important to understand those processes, which promote the accumulation and mobility of ^{137}Cs in soil as these directly influence their absorption by plants. As a result, vulnerable areas can be identified for optimal implementation of countermeasures to minimize internal and external exposures.

Absalom et al. (2001) presented a model, which predicts ^{137}Cs soil–plant transfer factors on the basis of easily measurable soil characteristics (clay content, organic carbon content, exchangeable potassium and pH). This model has been applied mainly to grass and grassy vegetations, however, there exist versions parameterised for other crops (Absalom et al., 1999). The Absalom model has been tested in temperate environments in Europe by successful application to the Chernobyl scenario (SAVE-IT Summary, 1999, http://www.nottingham.ac.uk/environmental-modelling/) and weapons' fallout ^{137}Cs scenario (Wright et al., 1999). However, this model has hardly been tested for the tropical food chains that prevail in many Southeast Asian countries like Bangladesh. Since many Southeast Asian countries are expanding in applications of nuclear technology, a comparable model is required to predict the impact of ^{137}Cs fallout deposited on the soil–plant system. This effort has been limited due to lack of appropriate data.