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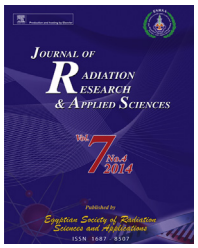

A study on the impact of phosphate fertilizers on the radioactivity profile of cultivated soils in Srirangam (Tamil Nadu, India)

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ABSTRACT

Phosphate fertilizers are enriched with ^{238}U during its production from phosphate rocks. Since, application of phosphate fertilizers in modern agriculture is ever on the increase, the present study investigated the impact of phosphate fertilizers on the radioactivity profile of cultivated (fertilized) soils as against virgin soils. Thirty soil samples each from cultivated fields and virgin fields were collected from Srirangam taluk and analyzed for the activity concentrations of ^{238}U, ^{232}Th and ^{40}K employing gamma ray spectrometry. Similar analysis was also undertaken in commonly used phosphate fertilizers. Among the phosphate fertilizers analyzed single super phosphate (396.3 Bq/kg) and triple super phosphate (284.2 Bq/kg) registered higher level of ^{238}U. The mean activity level of ^{238}U in cultivated soil (8.4 Bq/kg) was 25% higher than that of virgin soil (6.8 Bq/kg), while the mean ^{232}Th and ^{40}K activities in cultivated soil (98.4 Bq/kg & 436 Bq/kg) were elevated by 12.4% and 4% respectively as compared to virgin soil (87.5 Bq/kg & 419 Bq/kg). The mean radium equivalent (Ra_{eq}) value for virgin and cultivated soil samples was found to be 164.5 Bq/kg and 181.7 Bq/kg respectively. It is evident that the application of phosphate fertilizers elevated ^{238}U level of the soil. However, the mean Ra_{eq} value for soil samples is well below the permissible limit of 370 Bq/kg and hence cultivated soils do not pose any radiological risk.

1. Introduction

The terrestrial gamma radiation has a direct bearing on the concentration of primordial radionuclides such as ^{238}U and ^{232}Th and their decay products and singly occurring ^{40}K in soil and rocks of the environment. Natural radioactivity and the associated external exposure due to gamma radiation depend mainly on the local geological and geographical conditions that appear at different levels in each region in the world

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(UNSCEAR, 2000). Anthropogenic activity particularly application of phosphate fertilizer significantly increases the radioactivity level of cultivated soil as compared to soil from barren land. Khalifa and El-Arabi (2005) reported that phosphate rocks of sedimentary origin contain relatively high concentrations of ^{238}U and its decay products (U, Th, Ra, Bi and Pb) because of accumulation of dissolved uranyl complex, in the sea water during geological formation of the phosphate rocks. When phosphate fertilizers are produced from phosphatic rock they become enriched with ^{238}U (Mazzilli, Palmiro, Saueia, & Nisti, 2000). The concentration of primordials in various phosphate fertilizers is reported from different regions of the world (Al-Jundi et al., 2008; Khan, Khan, Tufail, Khatibeh, & Ahmad, 1998; Khater & Al-Sewaidan, 2008). Also correlation between application of phosphate fertilizers and levels of radioactivity of soil was reported by Akhtar, Tufail, and Ashraf (2005), Akhtar, Tufail, Ashraf, and Mohsin Iqbal (2005), Boukhenfouf and Boucenna (2011), and Ghosh, Deb, Bera, Sengupta, and Patra (2008). In India the annual consumption of chemical fertilizers has increased from 0.7 lakh metric tons in 1951–52 to 277.39 lakh metric tons in 2011–12, while per hectare consumption of fertilizer which was less than 1 kg in 1951–52 has risen to a level of 141.3 kg in 2011–12 (Ministry of Chemicals and Fertilizers, 2013). However scientific study of the impact of phosphate application on the radioactivity profile of cultivated soil is lacking. Hence the present study is undertaken to estimate the radiological impact on the soil due to the input of phosphatic fertilizers and their significant radiological risk to human beings in Srirangam taluk.

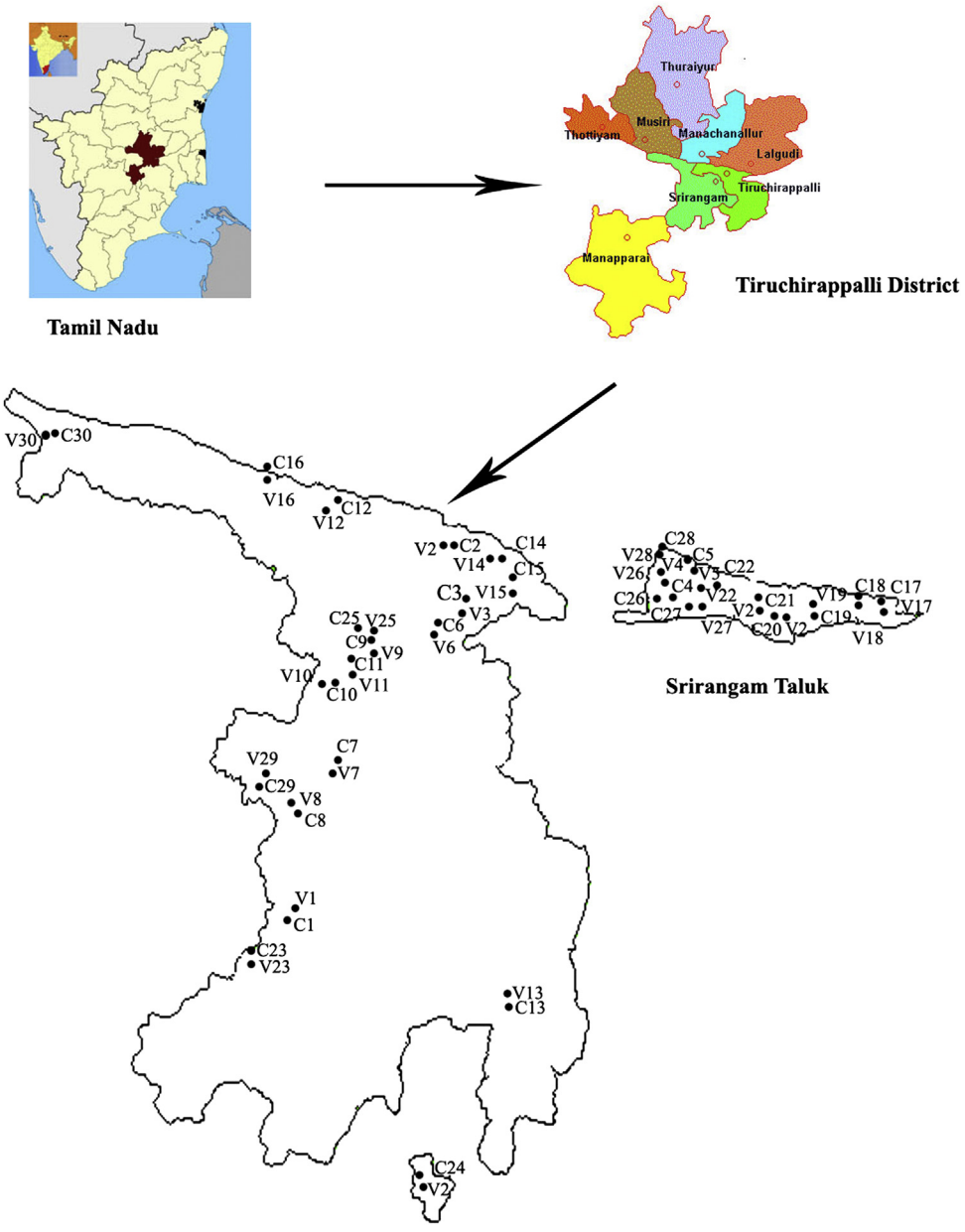

Fig. 1 – Study area and sampling stations.