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R

SHORT COMMUNICATION

Comparative Uptake of Thorium-230, Radium-226, Lead-210 and Polonium-210 by Plants

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WHILE the uptake of ^{230}Th, ^{226}Ra, ^{210}Pb and ^{210}Po, the long-lived radionuclides of uranium series, by plants from nutrient solution and soil has been reported,[1–8,10,11,12,14] no quantitative data are available on their entry and translocation measured under closely comparable conditions. Since this information is likely to be of value in establishing the relative significance of different nuclides as sources of natural radioactivity in plant populations, we have examined these aspects in nutrient culture experiments. Strontium-89, a fission product nuclide of radiobiological significance, was included for comparison.

Red kidney beans (*Phaseolus vulgaris* L.) var. Local were grown in water culture and when 15 days old the plants were transferred to polythene jars containing 1000 ml fresh nutrient solution. The nutrient solution contained K^+, 3·0; Ca^{++}, 8·0; Mg^{++}, 3·0; NO_3^-, 10·0; SO_4^{--}, 3·0; $H_2PO_4^-$, 1·0; m equiv/l together with micronutrients Fe, Mn, Cu, Zn, B and Mo. The pH of the solution was 5·0. Each radionuclide constituted a separate treatment and was added in carrier free state at the activity level of 0·25 μCi/L to five replicate jars. The experiment was conducted in a growth room where temperature was maintained at 23 ± 1°C, relative humidity at 65 ± 2 per cent and the plants were illuminated in 12 hr periods at 800 ft-c. The duration of the treatment was 15 days and the transpiration losses from the solution were made up daily with distilled water.

After treatment, roots were separated from shoots and the entrained solution was removed from roots by blotting. The tissues were dried at 90°C and wet ashed using nitric acid to obtain clear extracts which were taken up for radioassay. ^{226}Ra and ^{210}Pb were assayed by gamma spectrometry using a well-type 3×3 in. NaI (Tl) crystal integral line assembly, and a 512-channel pulse height analyser attached to an oscilloscope and computer readout typewriter. For the assay of ^{226}Ra, measurements were made of the 610 KeV peak of its daughter ^{214}Bi after allowing ^{214}Bi to attain equilibrium with ^{226}Ra in a sealed ampoule.[4] ^{210}Pb was assayed by measurement of its gamma peak at 47 KeV.[1] ^{230}Th was coprecipitated as fluoride with neodymium carrier and its alpha activity was measured in a low background ZnS (Ag) scintillation counter.[13] For assay of ^{210}Po and ^{89}Sr aliquots of the extracts were dried and counted in a low background alpha scintillation counter and a Geiger–Muller counter respectively.[1] Since each plant tissue sample contained only one radionuclide no interference from other nuclides occurred during radioassay. The radioassay data were corrected for background and processed to compute per cent uptake, concentration factor and transport index for each nuclide (Table 1).

Data presented in Table 1 indicate that accumulation of ^{230}Th, ^{210}Pb and ^{210}Po occurs predominantly in roots and only very small amounts of these nuclides are translocated to shoots. Over comparable periods, the accumulation of ^{226}Ra in roots is 2–3 times lower than that of the other nuclides of uranium series. However, the most significant difference between ^{226}Ra and other nuclides is in the extent of their upward transport which for radium is 50–200

Table 1. *Comparative uptake of different radionuclides by bean plants. Duration of treatment in labelled nutrient solution: 15 days*

Radionuclide	Uptake % of added		Concentration factor*		Transport† index
	Shoots	Roots	Shoots	Roots	
^{232}Th	0·09	76·35	0·91	4185	0·12
^{226}Ra	9·61	36·98	84·60	1787	20·62
^{210}Pb	0·29	90·64	2·69	4246	0·32
^{210}Po	0·06	68·01	0·58	3324	0·09
^{85}Sr	8·77	2·80	83·14	142	75·82
L.s.d. ($p = 0·05$)	2·06	20·05	5·83	1217	—

$$*\text{Concentration factor} = \frac{\text{Radionuclide content/g plant tissue}}{\text{Radionuclide content/ml nutrient solution.}}$$

$$\dagger\text{Transport index} = \frac{\text{Shoot content}}{\text{Total plant content}} \times 100.$$

times greater. Further, the amount of radium translocated to shoots is comparable to that of strontium.

The present evidence of relatively rapid transfer of ^{226}Ra to shoots suggests that among the nuclides examined here ^{226}Ra is likely to make the major contribution to radioactivity in aerial tissues of plants grown under conditions where root absorption is the principal route of entry of the nuclides. In situations where plant organs are subject to considerable atmospheric washout of ^{222}Rn daughter products, however, higher concentrations of ^{210}Pb and ^{210}Po than ^{226}Ra may be obtained.

It has been reported by MAYNEORD *et al.*,[6] EISENBUD *et al.*[2] and MISTRY *et al.*[9] that the contribution of radium isotopes to the alpha activity found in the stem, leaves and fruits of plants growing in the uranium and thorium rich high background radiation areas far exceeds that of thorium isotopes. The present findings from nutrient culture experiments are compatible with the above reports.

When plants are grown in soil containing uranium series nuclides their accumulation in roots is considerably lower than that in roots of plants grown in labelled nutrient solution as a result of the great affinity of these nuclides for exchange sites on the soil.[3,5,6,13] Furthermore, comparative uptake of the nuclides from soil is likely to be influenced by various factors which control their availability in the soil. In future we plan to examine the uptake of these radionuclides by plants from contrasting soil types.

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T. J. D'SOUZA
K. B. MISTRY

Biology Division
Bhabha Atomic Research Centre
Trombay, Bombay, India

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