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A STUDY OF URANIUM UPTAKE IN PLANTS

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Abstract - A fission track technique has been used to study the uptake of uranium in Tomato Plant. The Lexan plastic has been employed as the external detector for recording induced fission tracks due to uranium. The uranium uptake rate is found to increase as the growth proceeds. The uranium concentration is also determined in Phlox, Calendula and Dog Flower, grown under normal conditions. The uranium content is found to vary in different parts of the plants.

1. INTRODUCTION

Uranium is present as an impurity in almost all the materials including plants[1-5]. In plants, uranium gets transported through the roots to the stem and leaves. Normally the radioactive trace elements in vegetation are determined by Fluorimetry, Chlorimetry, Radiometric and Emission analysis. Since the discovery of solid state nuclear track detectors, an additional method is available to determine uranium, boron and thorium concentrations[6-9].

In the present investigations, an attempt has been made to study the uptake of uranium in different parts of a selected plant using fission track method. Known varying amounts of uranium were introduced in the soil and the uptake was recorded for different periods during growth. Such investigations can be helpful in biogeochemical exploration for uranium and for the measurement of level of radioactivity in edible plants for the study of health hazard.

2. EXPERIMENTAL

Dry viable seeds of Tomato were sown in soil contaminated with Uranyl nitrate [$UO_2(NO_3)_2\ 6H_2O$]. The nutrient fluid was a simple solution of Uranyl nitrate in water. Three concentrations viz. 100, 250 and 500 ppm were used with two pots for each concentration and eight seeds per pot of the plants. Two pots untreated with Uranyl nitrate served as control for the plant and each pot was identical. The experiment was conducted in the botanical garden of Guru Nanak Dev University, Amritsar and care was taken to ensure that differences in environmental factors were minimized, that plants were watered in the same way and at the same time. Fortnightly measurements of plant growth were recorded in every case. Three plants namely Phlox, Calendula and Dog Flower growing under normal conditions were also analysed for uranium content.

The uranium content in the plant samples was determined by using the external detector method. The experimental details are the same as reported earlier[7,9]. The comparison between track densities registered on overlay detectors (Lexan Plastic) due to sample pellet and that of standard glass dosimeter of known uranium concentration irradiated simultaneously with thermal neutrons gives a measure of average uranium concentration in the samples. The uranium concentration in the unknown can be expressed as[5,9].

$$\frac{U_x}{U_s} = \frac{T_x}{T_s}\ \frac{I_s}{I_x}\ \frac{R_s}{R_x} \qquad (1)$$

where the subscripts x and s stand for unknown and standard respectively,

U, the Uranium Content, T the fission track density, I the isotopic abundance ratio of U^{235} to U^{238} and R, the range of fission fragments in mg/cm^2. The correction factor (R_s/R_x) is taken to be unity. Similarly taking (I_s/I_x) as unity the equation becomes:

$$\frac{U_x}{U_s} = \frac{T_x}{T_s} \qquad (2)$$

In the present work, the concentration of Uranium in the standard glass dosimeter (SRM 614) used is 20 ppm. The irradiation of the samples was done in the CIRUS Reactor at BARC Trombay, Bombay with a total thermal neutron dose of 10^{15}(nvt).

3. RESULTS AND DISCUSSION

The results for uranium content determined in different parts of Tomato plant contaminated compared with the observations made on the control are given in Table 1. The uranium concentration in different parts of the

Table 1. Uranium uptake in Tomato plant
Total thermal neutron dose = 10^{15}(nvt)
U-Content in the dosimeter = 20 ppm

Time (days)	Activity (ppm)	Uranium Concentration (ppm)		
		Root	Stem	Leaf
15	Control	4.75 ± 0.27	2.19 ± 0.18	2.01 ± 0.17
30		9.28 ± 0.52	5.65 ± 0.41	4.11 ± 0.35
45		14.51 ± 0.51	8.14 ± 0.38	6.23 ± 0.34
15	500	282.87 ±14.84	19.69 ± 0.55	9.07 ± 0.38
30		274.16 ±21.45	45.18 ± 1.41	32.76 ± 1.18
45		315.49 ±16.87	78.18 ± 2.17	66.70 ± 2.45
15	250	130.27 ± 3.18	8.48 ±0.36	4.01 ± 0.25
30		261.00 ±21.41	30.42 ± 1.15	17.92 ± 1.26
45		270.23 ±15.61	60.34 ± 1.64	45.38 ± 1.43
15	100	95.89 ± 1.93	8.57 ± 0.36	4.06 ± 0.25
30		111.41 ± 3.12	26.38 ± 1.522	20.35 ± 0.92
45		115.35 ± 3.22	31.42 ± 1.68	36.41 ± 1.281

plant is found to vary with time, being more in roots and less in stem and leaf. The uranium content values in Phlox, Calendula and Dog Flower are reported in Table 2. In case of these plants too the uranium content is

Table 2. Uranium content in some plant species
Total thermal neutron dose = 10^{15}(nvt)
U-Content in the dosimeter = 20 ppm

Plant type	Uranium Concentration (ppm)		
	Root	Stem	Leaf
Phlox	5.44 ± 0.17	1.27 ± 0.08	1.51 ± 0.09
Calendula	17.99 ± 0.93	2.26 ± 0.11	1.75 ± 0.99
Dog Flower	2.87 ± 0.13	1.035± 0.07	1.40 ± 0.09

maximum in roots and minimum in leaves. The behaviour has already been reported[8] for Cyclanthera pedata plant using fission track method. Under the same environmental conditions the uranium content in the plant Calendula is found to be more than that in Phlox and Dog Flower. This shows that the uranium uptake also depends on the nature of the plant specie. Fig.1 shows the changes observed in various parts of Tomato as growth proceeds. From the figure it is clear that with growth period the uranium uptake rate increases and a plateau is reached for all parts of

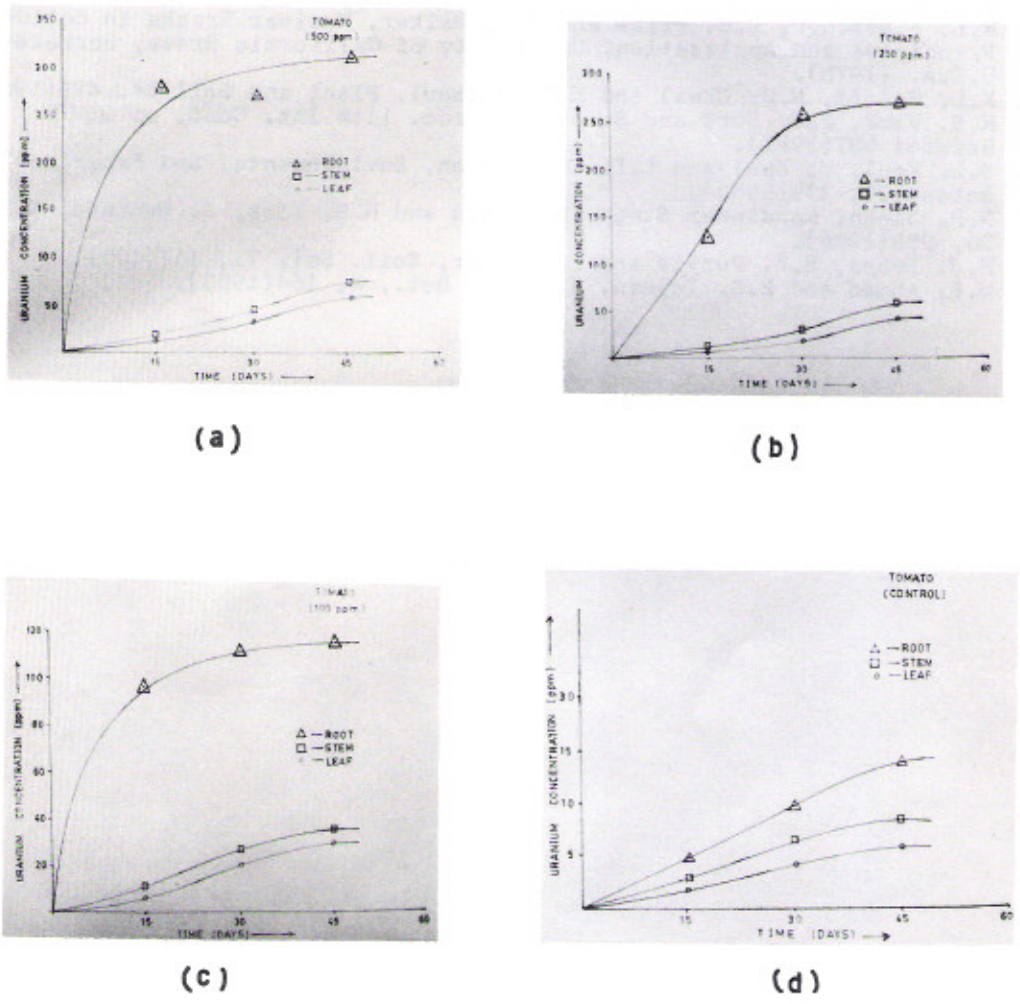

Fig.1 Variation of uranium concentration as growth proceeds when uranium concentration is (a) 500 ppm (b) 250 ppm (c) 100 ppm and (d) control.

the plant.

The maximum uptake of uranium in Tomato plant is observed for uranium contamination of 100 and 250 ppm, in the soil. A complete uptake of uranium is not observed in case of 500 ppm contamination. This may be due to the suppression by other elements already present in the nutrient solution and soil[10,11].

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