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The measurement of alpha radioactivity in plants by the use of different fertilizers used in agriculture soil

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Abstract
Phosphate fertilizer is one of the most important sources of exposure due to radiation and different types of radioactive nuclides are present in it. Fertilizers are commonly used in agricultural worldwide to enhance the crop yield. Naturally occurring radioactive elements are present in the plants, transferred to human beings via food products which are the main source of continuous radiation exposure. A control study has been carried out on the plants grown in earthen pots. The alpha track densities have been measured using solid state nuclear track detectors (SSNTD), a very sensitive detector for alpha particles. The alpha track densities (T $cm^{-2}d^{-1}$) are measured in plants after plantation. The result shows that alpha track densities vary with nature of fertilizers added to the soil and an increase has also been observed with time.

Keywords: radioactivity, fertilizers, alpha track density

1. Introduction
Phosphate rocks are the starting material for the production of all phosphate products and the main source of phosphorus for fertilizers (Bolca *et al.*, 2007) [1]. Soil-plant-man is recognized as one of the major pathway for transfer of radionuclide to human being (IAEA, 1982) [2]. Phosphate rock is an important raw material used for manufacturing different types of phosphate fertilizers. In addition to being the main source of continuous radiation exposure to human, soil acts as a medium of migration for transfer of radionuclides to the biological systems and hence, it is the basic indicator of radiological contamination in the environment (AI-Hamarneh and Awadallah, 2009) [3]. Heavy metal-contaminated soil is one of the widespread global problems. In the chemical wet process, phosphate rocks are treated with sulphuric acid, generating in addition to phosphoric acid (PA), a by-product called phosphogypsum (Roselli *et al.*, 2010) [4]. The common phosphate fertilizers (containing N, P, K) are triple super phosphate (TSP), single super phosphate (SSP), monoammonium phosphate (MAP) and diammonium phosphate (DAP). Cosmic radiation is highly penetrating, with a mean energy of approximately 10^4 MeV (Eisenbud, and Gesell, 1997) [5]. Some of this cosmic radiation originates from the sun.The international standards allow upto 20 mSv a year exposure for those who work with and around the establishments handling radioactive materials. Average exposures for radiation workers in different fields at global level are in the range of 2 to 8 mSv/y (NCRP, 1987) [6].
In the present work, the estimation of alpha activity in leaves of lady's finger plants grown using different types of fertilizers like diammonium phosphate (DAP), NPK, single super phosphate (SSP), urea, zinc sulphate (ZnS), potash, ammonium sulphate and organic fertilizer in same amounts before the plantation of the seedlings, has been made. Lady's Finger with botanical name Abelmoschus esculentus (Linn) Moench, belongs to Malvaceae family.

2. Experimental Details
The tracks etch technique which is the simplest and feasible and an efficient passive method has been used to determine alpha activity in plants of lady's finger **(**Citrullus vul; garis Schard). In the present control study plants were grown in earthen pots having equal amounts of (12kg) of same type of soil. Equal amounts (30 gm) of fertilizers like D.A.P. (Diammonium Phosphate), NPK (nitrogen, phosphorus and potassium), single super phosphate (SSP), urea, zinc sulphate ($ZnSO_4$), potash, organic fertilizers and cow dung manure were added to the soil just before the plantation of the seeds of lady's finger in the pots. The healthy leaves from different samples of plants after regular interval of 30 days were plucked, dried in an oven at 40 °C and then sandwiched between two plastic track detectors each of same size (2 cm x 2 cm**)** by wrapping a cello tape tightly to record the tracks for alpha radiations emitted from both upper and bottom faces of the leaves. The exposure time of the detectors was 60 days. At the end of exposure time, the detectors were removed and subjected to a chemical etching process in 2.5 NaoH solution at 60 °C for one and half hour. The detectors were washed, dried and after that, the tracks caused by alpha radiations emitted from the leaves were counted using an optical Olympus microscope using CCTV camera and a monitor at magnification 400 *X*. Numbers of tracks per unit area in the detector is proportional to average exposure rate and exposure time. Large numbers of graticular fields of the detectors were scanned to reduce the statistical error.

3. Results and Discussion
The alpha track densities have measured from the collected leaves at the top and bottom of lady's finger plant. After 30 days of plantation of the seeds, leaves were plucked from the plants that were grown in earthen pots, it has been found that the alpha track densities on the top face of the leaves varied from 83 to 992 T cm^{-2} while at the bottom face these varied

from 165 to 1239 T cm^{-2} with an average of 227±86 to 1033±29 as shown in table-1. It is found to be higher on its bottom face as compared to that on the upper face which may be due to the presence of large number of trichomes at the lower face to which dust particle from environment with the radon daughter attached, and get stuck. For a given leaf, alpha activity to be higher in the middle portion of the leaf as compared to that in regions near the tip of leaf and the part of leaf near to the stem. This may be due to the higher trichome density in the middle portion of leaves. The track density per day is higher for D.A.P. (Diammonium Phosphate), SSP, zinc sulphate ($ZnSO_4$) and potash as compared to other fertilizers. It may be due to the agriculture phosphate fertilizer industries use raw materials that consists of phosphate rocks, phosphoric acid, ammonium phosphate, ammonium sulphate, dolomite, limestone, potassium ores (potassium sulphate, potassium chloride), and nitrogen based compounds (ammonium nitrate, nitric acid) as the plant growth depends mainly on nitrogen, phosphorus, and potassium.

4. Conclusions

From present investigation we can conclude that:

- The alpha track densities vary with the nature of fertilizers added to the soil for the growth of plants and with the passage of time of growth due to large absorption of fertilizers by plants.
- The alpha activity is found to be more in case of ZnSO4, potash, and D.A.P. (Diammonium phosphate) fertilizers as compared to others. The main reason of it is the presence of uranium in phosphate fertilizers.

Table 1: Alpha track densities measured in the leaves of lady's finger plants after 30 days of plantation

Sr. No.	Fertilizer used	Tracks/cm^2 On Leaves Top face	Bottom face	AM±SE*	T $cm^{-2}d^{-1}$
1.	WF	165	331	289±46	4.7
		248	413		
2.	CDM	165	248	248±29	4.1
		248	331		
3.	DAP	992	1074	1033±29	17.3
4.	NPK	662	826	744±58	12.4
5.	SSP	662	909	744±93	12.4
		578	826		
6.	PF	826	1074	1013±113	16.8
		909	1239		
7.	$ZnSO_4$	744	909	868±65	14.4
		826	992		
8.	URA	578	662	619±65	10.3
		496	744		
9.	OF	83	165	227±86	3.7
		248	413.3		

*AM= Arithmetic Mean, SE= Standard error ($\sigma/\sqrt{N}$), where σ is Standard deviation and N is the no. of observations
WF=without fertilizer, CDM= cow dung manure, DAP= Diammonium Phosphate
NPK = Nitrogen, Phosphorous, and Potassium, SSP= single super phosphate,
PF= Potash Fertilizer, $ZnSO_4$ =zinc sulphate, URA= Urea, OF= organic fertilizer

5. References

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