

Alpha Radioactivity enhancement in Plants using chemical fertilizers

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Abstract

The Human and other living organisms are continuously exposed to ionizing radiation from natural and anthropogenic sources which are present everywhere in the environment. The important source of naturally occurring background radiation comes from cosmic radiations. The cosmic component, on the other hand, originates from outer space as cosmic rays whose contribution to the background changes mainly with elevation and latitude. In the present investigation, a control study has been carried out on the plants grown in earthen pots to observe the effect of fertilizers. The alpha track densities have been measured using solid state nuclear track detectors (SSNTD), a very sensitive detector for alpha particles. The measured alpha track densities ($T \text{ cm}^{-2}\text{d}^{-1}$) in lady's finger plants after 50 and 70 days of plantation varied from 4.2 to 20.7 and 8.2 to 22.2 respectively in various leaf samples. 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: Alpha Radioactivity, Soil, Fertilizers, Plants, Alpha track density

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1. Introduction

Exposure to ionizing radiation from natural sources is a continuous and unavoidable feature of life on earth. Natural sources of radiation provide an overwhelming contribution to annual exposures received by the population of the earth. The Human and other living organisms are continuously exposed to ionizing radiation from natural and anthropogenic sources which are present everywhere in the environment (Rahman et al., 2011). The basic component of our life support system is considered to be in the soil, water, and air. These environmental components contain measurable amount of radioactivity. 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 (Al-Hamarneh et al., 2009). High background radiation areas (HBRAs) are due to local geology, location, altitude and geochemical effects that cause enhanced levels of terrestrial radiation (UNSCEAR, 1993). Such exposures, while having

been the subject of much research, are not of concern for radiation protection (Saïdou et al., 2011). 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, economical, and feasible and an efficient passive method has been used to determine alpha activity in plants of lady's finger (*Citrullus vul;* garis Schard). Keeping in mind plants were grown in earthen pots having equal amounts of (12kg) of same type of soil and 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 in the pots. The healthy leaves from different samples of plants after regular interval were plucked, dried in an oven at $40\text{ }^{\circ}\text{C}$ 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 solutions at $60\text{ }^{\circ}\text{C}$ 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.

3. Results and discussion

The variations in alpha track densities at the top and bottom faces of the leaves of lady's finger plant are found to be there for the same leaf. For leaves plucked from the plants after 50 days of plantation of the seeds, it has been found that the alpha track densities on the top face of the leaves varied from 165 to 1157 T cm^{-2} while at the bottom face these varied from 331 to 1323 T cm^{-2} with an average of 248 ± 58 to 1239 ± 58 as shown in table-1. For leaves plucked from the plants after 70 days of plantation of the seeds, it has been found that the alpha track densities on the top face of the leaves varied from 413 to 1157 T cm^{-2} while at the bottom face these varied from 578 to 1487 T cm^{-2} with an average of 496 ± 58 to 1323 ± 117 as shown in table-2. Alpha track density is higher in regions near the tip of leaf and the part of leaf near to the stem. 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.

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. The alpha activity is found to be more in case of ZnSO₄, potash, and D.A.P. (Diammonium phosphate) fertilizers as compared to others. This may be due to the fact that the rock mineral apatite, from which phosphate is derived, is rich in uranium and its decay products.

Table 1 Alpha track densities measured in the leaves of lady's finger plants after 50 days of plantation

Sr. No.	Fertilizer Used	Tracks/cm ² on Leaves		AM±SE*	Tcm ⁻² d ⁻¹
		Top face	Bottom face		
1.	WF	248	413	331±58	6.8
2.	CDM	331	496	414±58	5.7
3.	DAP	1157	1323	1239±58	20.7
4.	NPK	826	992	909±58	15.3
5.	SSP	744	909	826±58	13.6
6.	PF	1074	1157	1116±29	18.5
7.	ZnSO ₄	826	992	909±58	15.4
8.	URA	661	909	785±88	13.2
9.	OF	165	331	248±58	4.2

Table 2 Alpha track densities measured in the leaves of lady's finger plants after 70 days of plantation

Sr. No.	Fertilizer Used	Tracks/cm ² on Leaves		AM±SE*	Tcm ⁻² d ⁻¹
		Top face	Bottom face		
1.	WF	413	578	496±58	8.2
2.	CDM	661	744	703±29	11.8
3.	DAP	1157	1487	1323±117	22.2
4.	NPK	992	1074	1033±29	17.3
5.	SSP	909	1074	992±61	16.7
6.	PF	1157	1405	1281±88	21.5
7.	ZnSO ₄	992	1157	1075±58	17.8
8.	URA	826	992	909±58	15.2
9.	OF	661	744	703±29	11.6

*AM= Arithmetic Mean, SE= Standard error (σ/\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

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