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Research paper

Alpha activity emitted from leaves and roots of beetroot plant planted in enhanced soil with fertilizers

Sahar Ahmed Amin *

Environmental Research Center, University of Technology- Iraq
**Corresponding author E-mail: 11482@uotechnology.edu.iq*

Abstract

This study is to assesses radioactive materials transported to the beetroot plants grow in different fertilized soil. Equivalent weights of fertilizers were added to the soil prior the plantation. The alpha track densities were estimated utilizing solid state nuclear track detector (SSNTDs), CR-39. The obtained results show that alpha track densities in Beetroot plants in the lower and upper sides of plant leaves were varied from 67.62 Tr.cm−2 to 101.83 Tr.cm−2 and from 45.35 Tr.cm−2 to 94.67 Tr.cm−2 with mean values of 89.96 Tr.cm−2 and 68.48 Tr.cm−2, respectively. Alpha track densities were also measured in the samples of the enhanced plantation soil with fertilizers and in the whole parts of the Beetroot plant which were planted in these soils. These values were compared with alpha track densities obtained from fertilizer samples in the previous studies. The lower face of leaves gives higher α-particles activity than that obtained from the upper face. As well as, the alpha activity from the plants planted in soils enhanced with phosphate compost was found greater as contrast with that planted in a soil enhanced with organic fertilizer. The utilization of organic fertilizer don't cause much risks like contrasted with phosphate fertilizers. Therefore, the alpha activity depends on the nature of fertilizers added to the soil.

Keywords: *Fertilizers; Beetroot Plant; Radioactivity; Soil; SSNTDs.*

1. Introduction

Naturally occurring radiation is created as a result of unstable nuclei present in the earth's crust or from the atmosphere [1]. Under specific conditions, natural radioactive substances can be considered as dangerous radiological hazards. Thus, assessment of the radiation dose to population is important in order to identify the risks that affect human health and to beware of any future variations in the ecological radioactive materials and its effect on human activities [2].

Radioactivity is everywhere around us in the soil, air, water and plants which they have determinable quantity of radioactive materials. Metabolism process of plant organisms and physiochemical characteristics of the soil may cause accumulation of radio-isotopes in their organism species. Thus, this will in turn increase risk to humans through food chain. Radionuclides in the fertilizers are transferred to the plant when they applied to them [3]. Fertilizers are fundamental in the plant's nutrition. They contain many elements in addition to radioactive nuclei with their decay products. Phosphate fertilizers are considered as technologically enhanced natural radiation, which increases the environmental uranium and partially thorium concentrations in the environment [4]. Markose [5], Jibiri et al. [6] and many other researchers have studied the presence of radioactivity in plant organs. Humans are exposed to soil contamination through food chain (soil–plant–human) pathway and incidental soil ingestion (soil–human) pathway.

The predictable amount of radionuclides that get in a plant from soil is termed by soil-plant concentration ratio [7].

The investigation of natural radioactivity in plants and related radiation exposure through the particular nourishment materials is a significant consideration.

Microorganisms are naturally accompanying with plant roots which can directly or indirectly affect the movement, availability and acquirement of elements in the plants [8]. The usage of fertilizers in soil cause radiological effect due to lung internal irradiation by α-particles, radon and thoron progenies and the external irradiation of the body by gamma rays emitted from the radionuclides. Radon is harmful to humans and it makes the major natural radiation exposure to human being [9-11].

In the present work, alpha activity has been estimated in leaves of beetroot plants grown using different types of fertilizers like MAP (Monoammonium Phosphate), TSP (Triple Super Phosphate), NPK (nitrogen, phosphate and potassium), P_2O_5 (Phosphorus pentoxide), cryolite, zeolite, and organic fertilizer. The fertilizers have been added with the same amount before plantation.

The present study is important not only for the determination of levels of harmful pollutants discharged to the environment but also to assess how much living creatures gain due to food digestion. It is also important to understand the behavior of natural radionuclides in the environment, because such information can be used as the associated parameter values for the radiological assessments [12]. On the other hand, such information can be used as an important data in order to establish baseline data for the future radiation impact assessment, radiation protection and exploration [13].

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2. Materials and methods

CR-39 track detector was used to measure the activity of alpha particles in beetroot plant. Beetroot seeds were planted in planting pots containing equal amount of sandy soil (10kg). Nine types of fertilizers amount of 20g were added in each pot and one control pot with no additives. The added fertilizers were MAP, Cryolite, TSP, Zeolite, NPK, P_2O_5 and organic fertilizer. The seeds were planted at depth 2 to 3 cm from the soil surface. All pots were left outside at same environmental conditions and they were watered at regular period of time. When the plants grown up, three types of exposure have been made:

- Leaves from each sample were picked, washed with tap water to remove any contamination. After washing the leaves left to dry in normal room condition until they completely dry. Then each leaf sample was put between two pieces of CR-39 SSNTD's (size 3x3 cm^2), covered by aluminum foil sheet and kept into closed plastic containers to isolate the samples from the environment [14, 15].
- Whole parts of each plant samples were dried, crushed and sieved and a weight of 30 g of each were put in the bottom of a sealed container with a piece of CR-39 (1.5 x 1.5 cm^2) sticked in the inner side of the cover of the cup.
- A weight of 30 g of dry soil collected from each pot were put in the bottom of a sealed container with a piece of CR-39 (1.5 x 1.5 cm^2) sticked in the inner side of the cover of the cup.

After 60 days of exposure time, the pieces of CR-39 detectors were taken out and etched in 6.25 N of Sodium hydroxide solutions at 70 ^oC for 4 hrs. Then, by using optical microscope, α-tracks per unit area were counted.

3. Results and discussion

3.1. Alpha activity from beetroot plant leaves

Alpha track activities for the beetroot plant leaves planted in different fertilized soils were measured and the results are given in Table 1. The obtained results show that α-track activity of the lower and upper faces of the Beetroot leaves varied from 74.78 $Tr.cm^{-2}$ to 101.83 $Tr.cm^{-2}$ and 46.94 $Tr.cm^{-2}$ to 94.67 $Tr.cm^{-2}$with mean values of 93.61 $Tr.cm^{-2}$ and 70.01 $Tr.cm^{-2}$ respectively. The mean values of total α-track density and α-track density per day for both faces were 81.81 $Tr.cm^{-2}$ and 1.36 $Tr.cm^{-2}.\ d^{-1}$, respectively. The activities of α-track for the lower and upper faces of the beetroot plant sample grown in soil without fertilizers were 67.72 $Tr.cm^{-2}$ and 45.35 $Tr.cm^{-2}$ respectively with mean value of 56.49 $Tr.cm^{-2}$. The mean value of alpha track density/day was 1.36 $Tr.cm^{-2}.\ d^{-1}$.

Table 1: Total Alpha Track Activities Measured in the Beetroot Plant's Leaves

Fertilizer	Alpha track density ($Tr.cm^{-2}$)			Alpha track density/day ($Tr.\ cm^{-2}.d^{-1}$)
	Lower side	Upper side	Mean	Mean
Cryolite	100.24	46.94	73.59	1.23
NPK1	90.69	90.69	90.69	1.51
P2O5	101.03	89.10	95.07	1.58
Zeolite	98.65	68.42	83.53	1.39
TSP1	95.47	77.96	86.71	1.45
TSP2	80.35	68.42	74.38	1.24
MAP1	101.83	51.71	76.77	1.28
MAP2	99.44	94.67	97.06	1.62
Organic	74.78	48.53	61.65	1.03
Without	67.62	45.35	56.49	0.94
Min	74.78	46.94	61.65	1.03
Max	101.83	94.67	97.06	1.62
Mean	93.61	70.01	81.81	1.36

3.2. Alpha activity from the whole plant and Soil

Radon concentrations for whole plants and soil samples enhanced with different types of fertilizers are presented in Table 2 and Fig. 1. The lowest radon concentration found in soil samples enhanced with organic fertilizer with value of 604.61 Tr/cm^{-2} while the soil sample enhanced with MAP fertilizer gives the highest radon concentration with value of 1050.11 Tr/cm^{-2}. Whereas, the obtained results show that radon concentration in the beetroot plant grows in soil enhanced with organic fertilizer is the highest with value of 604.61 Tr/cm^{-2} while the lowest value was 310.26 Tr/cm^{-2} in the beetroot plant grows in the soil enhanced with NPK2 fertilizer.

Table 2: Alpha Track Density in Soil and Beetroot Plant Samples

Sample	Fertilizer (25)	Soil	Beetroot Plant
Cryolite	6125.70	883.05	477.33
NPK	5171.04	747.81	389.82
P2O5	8074.78	946.70	517.10
Zeolite	7159.90	891.01	501.19
TSP1	3699.28	636.44	389.82
TSP2	5608.59	835.32	445.51
MAP1	17859.98	1050.12	604.61
MAP2	12211.61	986.48	580.75
Organic	2505.97	604.61	326.17
Without	-------	580.75	310.26

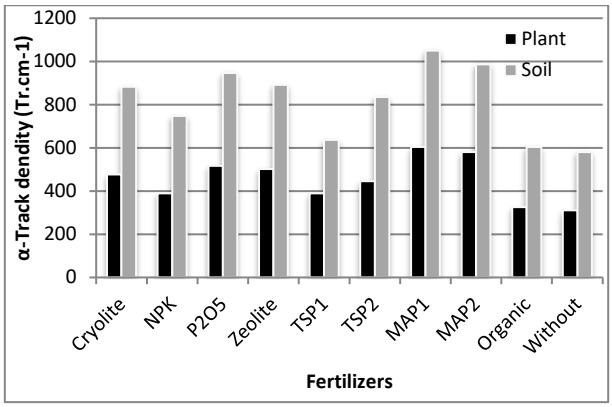

Fig. 1: Alpha Track Density for Soil and Plant Samples Enhanced with Different Types of Fertilizers.

The variation in alpha track density per day ($Tr.cm^{-2}.\ d^{-1}$) for different fertilized soil and for Beetroot plant planted in different fertilized soil compared with plain soil (not fertilized) are shown in Fig. 2. As well as, track density per day for the fertilizer samples [16] is also added in Fig. 2.

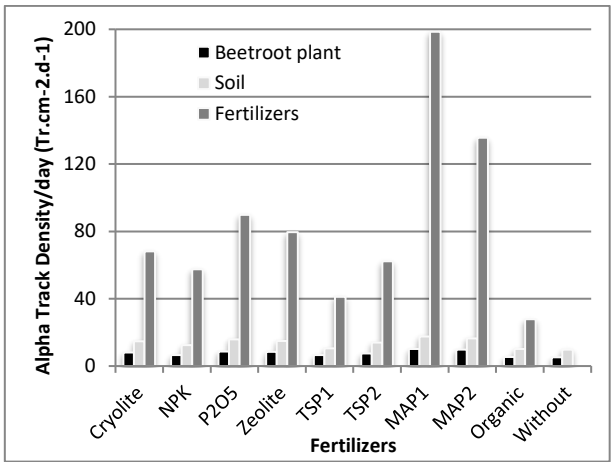

Fig. 2: Alpha Track Densities Per Day for Soil and Plant Samples Enhanced with Different Types of Fertilizers in Comparison with That of Fertilizers.

The plants that planted in fertilized soils gives higher activities than that planted in unfertilized soil. Alpha track activities from leaves of beetroot plant samples planted in the soils with addition of fertilizer were higher than that measured in the plant samples grown in organic soil. This might be ascribed to reality that the radioactive material (uranium and radium) concentrations in the soil were upgraded due to the addition of the phosphate fertilizers, where many scientists reported that high radioactive materials were content in such phosphate fertilizers [17, 18]. These radionuclides exchange from soil to plant alongside fundamental supplements and amass in different parts of the plants. The quantity of alpha tracks generated on CR-39 detector are specifically corresponding to radioactive materials exist in leaves, in this way with utilization of various fertilizers, the radioactive materials are increased in the plant as presented in the present work. Figs. 3 & 4 illustrate the alpha track density and alpha track density per day for both faces of beetroot plant leaves planted with different fertilizers.

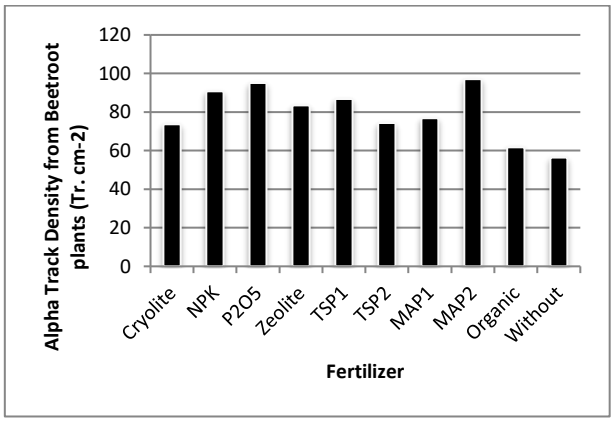

Fig. 3: Mean Values of A-Track Activity from Beetroot Leaves Planted in Soils Enhanced with Various Fertilizers Compared with That Planted in Row Soil.

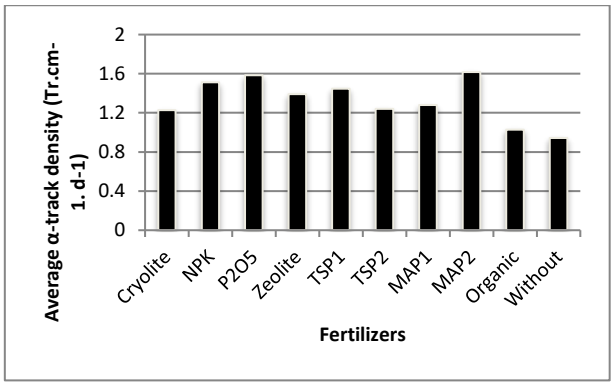

Fig. 4: Mean Values of A-Track Activity/Day from Beetroot Leaves Planted in Soils Enhanced with Various Fertilizers Compared with That Planted in Row Soil.

Organic fertilizer show the lowest α-track density per day with values of 5.44 $Tr.cm^{-2}.d^{-1}$ and 10.08 $Tr.cm^{-2}.d^{-1}$, While MAP1 fertilizer gives the highest α-track density per day with values of 10.61 $Tr.cm^{-2}.d^{-1}$and 17.50 $Tr.cm^{-2}.d^{-1}$ for beetroot plant and soil samples respectively. A positive correlation between α-track density obtained from soil and that's obtained Beetroot plants is shown in Fig. 5.

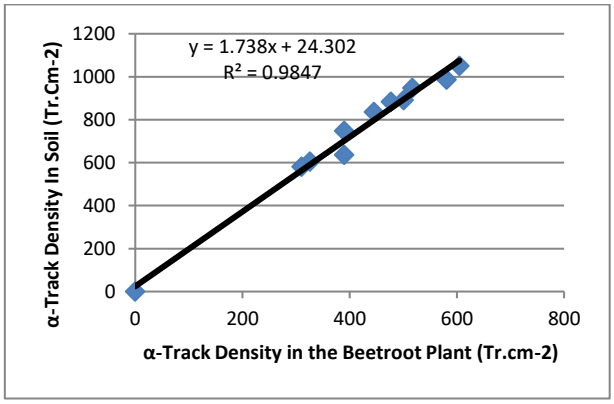

Fig. 5: Correlation of A-Track Densities between Alpha Track Density of Soil and Beetroot Plant Samples.

4. Conclusions

The utilization of natural and phosphate manures to build the yield creation is a typical practice in a large portion of the nations. The utilization of fertilized soil is the reason of the increment in exchange of radioactive materials from the soil to different parts of the plant. The activity of α-particles is found higher from the lower face of leaves than that from the upper face. This might be ascribed that the trichrome thickness at lower side of the leaves is greater than the upper side of the leaves.

The alpha activity from the plants planted in soils enhanced with phosphate compost was found greater as contrast with that planted in a soil enhanced with organic fertilizer. This might be ascribed to reality that the phosphate fertilizers contain higher concentrations of radioactive materials (radium and thorium). The utilization of organic fertilizer don't cause much risks like contrasted with phosphate fertilizers. This may have been brought about by the existence of uranium and radium in the phosphate rocks; crude materials utilized for the compost's generation.

Therefore, the alpha activity depends on the nature of fertilizers added to the soil. This might be because of the variety of level in radio nuclides in the fertilizers utilized for the plants growth.

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