



Surface Contamination and Dose Rate Verification of Fertilizers common in Iraqi Plantations using RadEye B20 Detector

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Abstract

Twenty-three samples of granular chemical fertilizers and organic fertilizers commonly utilized in Iraqi ranches were collected. The samples were prepaid and stored in a Marinelli beaker to measure; dose rate, general count rate and surface contamination of the samples using the RadEye B20 detector, firstly with shield, secondly without the shield to estimate the effect of shielding on the measurements. The results showed that using shield made a significant decrease in the radiation measurements reached about 25%. However, the mean value of surface contamination, dose rate and general count rate with shield were 0.54Bq/cm², 0.65μsv/h, and 0.28Cps respectively, and without shield being 0.34Bq/cm², 1.33μsv/h, and 1.52Cps respectively.

Keywords: Dose rate, surface contamination, RadEye B20, compound fertilizer, Marinelli beaker.

1. Introduction

In general, fertilizers are defined as the compounds that provide chemical elements and nutrients for plants. Fertilizers consist of three basic elements for plant growth, which are nitrogen, potassium, and phosphorous. Phosphorous is taken from phosphate rocks that contain a high proportion of naturally occurring U-238, Th-232, and K-40 and their radioactive daughters [1,2]. Using fertilizers have not shown any serious health problems during the previous ages. However, the frequent use of these fertilizers or their incorrect use may lead to very serious health problems for humans and animal [3]. The wider use of plant fertilizers in an ill-conceived manner increases the natural radiation level of the soil and thus exposes the environment to radiation pollution [4]. People exposed to critical levels of radiation from fertilizers are at risk for cancer, so it has become necessary to monitor the natural radioactivity resulting from these fertilizers in the perspective of radiation security [5,6]. RadEye B20 measuring the radiation doses around it or in the workplace (the



laboratory) with a warning sound is issued in the event of radiation in a certain area to ensure that the place is free of elements that may affect the accuracy of the readings and the personal safety of workers in the laboratory. General Count Rate Measurements (cps) value is always displayed in the top section of the LCD in order to remind the user that the measured value has been corrected by that particular count rate value. To detect hidden radiation sources, the alarm threshold must be set to the lowest value that does not produce fail alarms [7]. Reducing background radiation also getting maximum detection efficiency, redeye b20 is shielded by ORTEC cylindrical chamber. Shielding consists of two parts: the upper part thickness of 5 cm and a length of 20 cm with a cover of 5cm thick, diameter of 22 cm and 54 cm height [8].

The source of mineral phosphorus is Phosphate rock, which is found in many of the fertilizers utilized to assist plants grow strong roots [9]. More than a million ton of fertilizers are used annually all over the world to increase agricultural products as well as land reclamation for agriculture [10] and [11]. Using Phosphate containing fertilizers is the most source of the uranium input within the environment (about 73 % of the total input of uranium) [12] and [3]. Concentrations of radionuclides in animal (organic) fertilizers and fertilized soil samples are lower than those obtained in granular (inorganic) chemical fertilizers [13]. Using fertilizers in agricultural is a potential source of external and internal exposure to the farmers, animals and general public [14] and [15]. Chemical fertilizers (urea or superphosphate) interact with the plant, affecting the plant nutritional process [16,18]. External exposure is directly occurred by gamma rays as it emits from the radionuclides of the uranium chain (U-238), thorium chain (Th-232) and K-40 that exists inside phosphate rocks, which is the most important element in the fertilizer industry [2,17].

2. Materials and Methods

2.1 Collection and preparation of the Samples

In this study, twenty-three local and imported samples of the commonly granular fertilizers of organic and inorganic fertilizers used in Iraqi farms were collected from different agricultural offices and farms from all governorates of Iraq. Nine of these samples were Compound fertilizer, seven samples were Di-ammonium phosphate, and seven samples were organic as shown in table 1. Fertilizer samples were ground by a steel Grinder model 100 and sieved to a fine powder by German-made sieve with equal holes of 630 μ m. After preparation, samples were prepared with suitable masses from 375 gm to 1068 gm and stored in Marinelli beakers.

Table 1. Name, code, and manufacturing country of Compound fertilizer, Di-ammonium phosphate, and Organic samples respectively.

No.	Fertilizer Name	Code	Manufacturing Country	
Compound fertilizer	1	Npk.1	FS.1	Russia
	2	Npk.2	FS.2	U.A.E
	3	Npk.3	FS.3	Jordan
	4	Npk.4	FS.4	U.A.E
	5	Npk.5	FS.5	Jordan
	6	Npk + TE 2	FS.6	Spain
	7	Npk.6	FS.7	Norway
	8	Npk.7	FS.8	Spain
	9	Npk.8	FS.9	Italia
Di-ammonium phosphate	17	Di-ammonium Phosphate.1	FS.10	Lebanon
	18	Di-ammonium Phosphate.2	FS.11	Iraq
	19	Di-ammonium Phosphate.3	FS.12	Iraq
	20	Di-ammonium Phosphate.4	FS.13	Iran
	21	Di-ammonium Phosphate.5	FS.14	Qatar
	22	Di-ammonium Phosphate.6	FS.15	Jordan
	23	Di-ammonium Phosphate.7	FS .16	Jordan
Organic samples	10	Human Organic	FS.17	Holland
	11	Animal Organic	FS.18	Norway
	12	Organic.1	FS.19	China
	13	Organic.2	FS.20	Poland
	14	Organic.3	FS.21	Iraq
	15	Organic.4	FS.22	Iraq
	16	Leaves Organic	FS.23	Iraq

2.2 Digital Portable Detector (RadEye B20)

RadEye B20 a sensitive Germanium tube detector allowing the detection of low radiation levels, is related to measure the radioactive contamination of alpha and beta particles, gamma and x-ray photons, the gamma dose rate ranged from 17-1300 keV under an optional gamma energy filter, and the count per second.

Measurements with RadEye B20 were performed by placed the detector for five minutes -for each measure- on the surface of the sample which was previously stored in Marinelli beaker. Once when the baker was placed inside a shield (cylindrical lead shield) suitable for the beaker size as shown in figure 1 A., another when the baker was placed outside the shield (background) as shown in figure 1 B.



Figure 1. Surface Contamination Reading of Sample FS.6 with RadEye B20, (A) with shield and (B) without shield

3.Results and discussion

Table 2 shows the maximum values of Surface contamination, Dose rate, and General Count Rate per second measurements with shield are 1.775Bq/cm^2 , $0.8\mu\text{sv/h}$, and 4.755Cps respectively in the Spain Compound fertilizer sample (FS.6). The minimum values were found in the organic fertilizer sample (FS.20) equal 0.18Bq/cm^2 , $0.10\mu\text{sv/h}$, and 0.43Cps respectively. While the maximum measurements without shield were 2.105Bq/cm^2 , $1.035\mu\text{sv/h}$, and 5.115Cps respectively; the minimum values were 0.255Bq/cm^2 , $0.12\mu\text{sv/h}$, and 0.485Cps respectively. It was noticed that all measurements performed within shield were less than the measurements performed without shield by 75%. The mean values for all samples with and without shield were 0.54 and 0.65Bq/cm^2 for surface contamination, 0.28 and $0.34\mu\text{sv/h}$ for dose rate, 1.33 and 1.52Cps for count per second.

Table 2. Surface contamination, Dose rate, and Count Rate per second Measurements for fertilizer with and without shield.

Type	Code	Surface contamination (Bq/cm ²)		Dose rate μ sv/h		Count rate per second Cps.	
		With shield	without shield	With shield	without shield	With shield	without shield
Compound fertilizer	FS.1	1.05	1.17	0.41	0.44	2.35	2.45
	FS.2	0.25	0.3	0.13	0.16	0.51	0.87
	FS.3	1.56	1.71	0.67	0.57	4.26	4.88
	FS.4	0.32	0.43	0.14	0.19	0.84	1.09
	FS.5	0.32	0.67	0.14	0.2	0.77	0.97
	FS.6	1.77	2.10	0.8	1.03	4.75	5.11
	FS.7	1.12	1.27	0.53	0.59	2.67	2.78
	FS.8	0.80	0.87	0.35	0.4	1.83	2.06
	FS.9	1.27	1.36	0.65	0.86	2.85	3.11
Di-ammonium phosphate	FS.10	0.60	0.77	0.78	1	1.23	1.37
	FS.11	0.21	0.23	0.12	0.14	0.36	0.55
	FS.12	0.19	0.26	0.11	0.14	0.43	0.52
	FS.13	0.18	0.23	0.12	0.14	0.39	0.50
	FS.14	0.23	0.23	0.28	0.33	0.39	0.54
	FS.15	0.33	0.45	0.19	0.22	1.05	1.28
	FS.16	0.53	0.59	0.2	0.33	1.22	1.34
Organic	FS.17	0.22	0.41	0.12	0.21	0.78	0.93
	FS.18	0.30	0.41	0.17	0.17	0.96	1.05
	FS.19	0.26	0.39	0.14	0.2	0.80	0.89
	FS.20	0.18	0.25	0.10	0.12	0.43	0.48
	FS.21	0.21	0.27	0.15	0.13	0.54	0.73
	FS.22	0.29	0.35	0.12	0.18	0.69	0.80
	FS.23	0.29	0.27	0.11	0.15	0.52	0.67
Max.		1.77	2.10	0.8	1.03	4.75	5.11
Min.		0.18	0.25	0.10	0.12	0.43	0.48
Mean.		0.54	0.65	0.28	0.34	1.33	1.52
B.G.		0.15	0.21	0.09	0.12	0.09	0.38

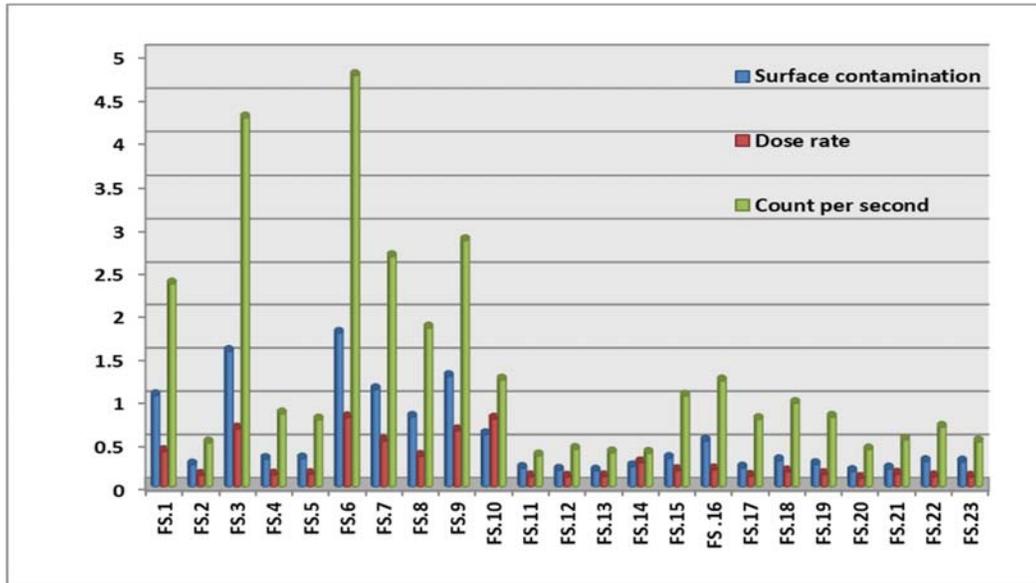


Figure 2. Surface contamination, Dose rate, and General Count Rate per second measurements with shield.

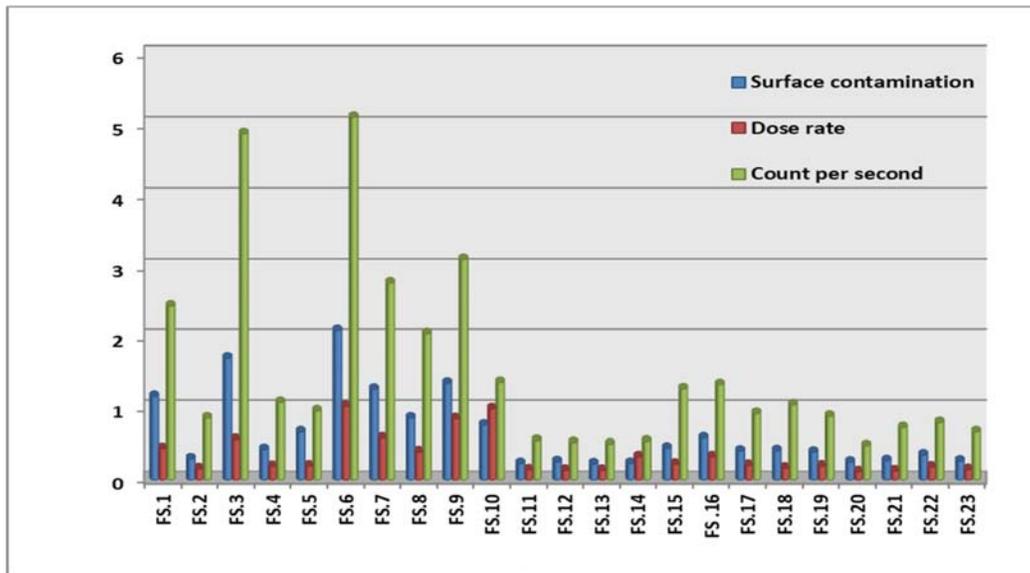


Figure 3. Surface contamination, Dose rate, and General Count Rate per second measurements without shield.

4. Conclusion

Three important measurements were made, dose rate, general counting rate, and surface contamination, with and without the shield for all fertilizer samples used in this study, using the RadEye B20 and lead shield Ortec type. The device' measurements varied according to the type of fertilizer due to the difference in its compounds, the percentages of these compounds, and the places from which they were collected. The lowest measurements recorded by the device were for natural organic fertilizer samples, with or without the shield, while the highest measurements were in Compound fertilizer and Di-ammonium phosphate samples, respectively, with or without the shield. It turned out that the shield had a big part in reducing radiation levels from fertilizers roughly 25% from its value in the background. From all these

results, it was found that the dose rate, the general count rate and surface contamination of organic fertilizers were less than the chemical compound fertilizers. Chemical fertilizers should not store inside homes and avoid dealing with it unless preparing safety gear. All those fertilizers can be used with the necessary precautions taken because the long-term application of chemical fertilizers can have an effect on the accumulation of radioactivity within soil, plant ends in the human body.

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