REVIEW

of the official reviewer for dissertation work

Nursapina Nurgul Armankyzy on the theme «Entering of natural radionuclides in soil and root crops with fertilizers and their distribution in "soil-plant" system» presented for the degree of Doctor of Philosophy (PhD) in the framework of educational programm 8D05301 «Chemistry».

№	Criteria	Eligibility (one of the options must be checked)	Justification of the position of the official reviewer
1.	The topic of the thesis (as of the date of its approval) corresponds to the directions of development of science and/or state programs	1.1 Compliance with priority areas of science development or government programs: 1) **The thesis was completed within the framework of a project or target program financed from the state budget (indicate the name and number of the project or program)** 2) The thesis was completed within the framework of another state program (indicate the name of the program) 3) The dissertation corresponds to the priority direction of the development of science, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction)	The thesis was carried out within the framework of a scientific project of the Ministry of Education and Science of the Republic of Kazakhstan, "Influence of application of mineral fertilizers on accumulation ability of radionuclides and heavy metals in root vegetables" grant number AP08052224, 2020 – 2022.
2.	Importance for science	The work **makes**/does not make a significant contribution to science, and its importance is well disclosed/not disclosed	Evaluation and forecasting of the quality of plant agricultural products are impossible without a clear understanding of the fundamental patterns of radionuclides behavior in the "soil-plant" system. Despite the large number of works devoted to the assessment of radionuclides migration in the "soil-plant" system, this work **makes an undoubted contribution** to the understanding of the fertilizers effect on the natural radionuclides bioavailability. The significance of the obtained results for scientific knowledge is **disclosed,** and directions

			for further use of the research results are determined.
3.	The principle of independence	Self-reliance level: 1) **High**; 2) Medium; 3) Low; 4) No independence	The self-reliance level the author consists in the analysis of scientific literature data, carrying out the vegetation experiment and analyzing of natural radionuclides in samples using alpha spectrometry method with preliminary radiochemical separation, evaluation and interpretation of obtaining results.
4.	The principle of inner unity	4.1 Justification of the relevance of the thesis: 1) **Justified**; 2) Partially justified; 3) Not justified.	The relevance of the thesis is well **justified** in the literature review, the research conducted is important for science.
		4.2 The content of the thesis reflects the topic of the thesis: 1) **Reflects**; 2) Partially reflects; 3) Does not reflect	The content of the thesis **reflects** the topic of the thesis.
		4.3. The purpose and objectives correspond to the topic of the thesis: 1) **correspond**; 2) partially correspond; 3) do not correspond	The purpose and objectives fully **correspond** to the topic of the thesis.
		4.4 All sections and provisions of the thesis are logically interconnected: 1) **completely interconnected**; 2) the interconnection is partial; 3) there is no interconnection	All sections and provisions of the thesis are **completely interconnected**.
		4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions: 1) **there is a critical analysis**; 2) partial analysis; 3) the analysis does not represent one's own	The solutions proposed by the author are substantiated and confirmed by research using modern methods of physical-chemical, spectral, biological and statistical analysis. At each stage of the work, the author makes evidence-based and experimentally confirmed conclusions.

		opinions, but quotes from other authors	
5.	Scientific novelty principle	5.1 Are the scientific results and provisions new? 1) **completely new**; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The scientific novelty of the work lies in studying the effect of fertilizers on the migration of natural radionuclides in the "soil-plant" system. The effect of 9 different fertilizers on the mobility and bioavailability of natural radionuclides in the soil of Almaty and Turkestan regions was assessed for the first time. Fertilizers that have the most significant effect on the mobility and bioavailability of radionuclides have been identified. An assessment of natural radionuclides uptake by carrots and radishes is given, taking into account the applied fertilizers. The results of the study can be used in developing recommendations for agricultural management.
		5.2 Are the dissertation findings new? **1) completely new;** 2) partially new (25-75% are new); 3) not new (less than 25% are new)	
		5.3 Technical, technological, economic or management decisions are new and reasonable: **1) completely new;** 2) partially new (25-75% are new); 3) not new (less than 25% are new)	
6.	The validity of the main findings	All main conclusions are/are not based on scientifically significant evidence or well-grounded (for qualitative research and areas of training in the arts and humanities)	The degree of reliability and validity of the conclusions obtained in the work is based on a large experimental material, the use of modern extraction, physical-chemical, spectral, biological and statistical research methods. All the conclusions of the thesis correspond to the tasks and provisions.
7.	The main provisions for the defense	It is necessary to answer the following questions for each provision separately: 7.1 Is the provition proven? 1) **proven**; 2) rather proven; 3) rather not proven; 4) not proven 7.2 Is it trivial? 1) yes; 2) **no** 7.3 Is it new?	The main provisions are new and have theoretical and practical significance. **The provision 1** is proven in the experimental part of the work in Chapter 3.1. It has been shown in Table 5 that in fertilizers was determined a wide range of uranium, thorium, and radium activity concentrations, which have not exceeded 1000 Bq. The provision is new and not trivial. The level of application is "wide", since the results can be used in calculating doses, developing recommendations for agricultural management, radioecological

		1) **yes**; 2) no 7.4 Application level: 1) narrow; 2) medium; 3) **wide** 7.5 Is it proven in the article? 1) yes; 2) **no**	studies, etc.
		7.1 Is the provition proven? 1**) proven**; 2) rather proven; 3) rather not proven; 4) not proven 7.2 Is it trivial? 1) yes; 2) **no** 7.3 Is it new? 1) **yes**; 2) no 7.4 Application level: 1) narrow; 2) medium; 3) **wide** 7.5 Is it proven in the article? 1) **yes**; 2) no	**The provision 2** is proven in the experimental part of the work in Chapter 3.7 and 3.10. It has been shown in Figure 19 and 20 that application monopotassium phosphate leads to slightly increase of bioavailable and mobile form of U-234 and U-238. The natural radionuclides uptake by radish has been proven in an article Nursapina N.A., Shynybek B.A., Matveyeva I.V., Nazarkulova, Sh.N., Štrok M., Benedik L, Ponomarenko O.I. Effect of mineral fertilisers application on the transfer of natural radionuclides from soil to radish (Raphanus sativus L.) // Journal of Environmental Radioactivity, V.247, 2022. 10.1016/j.jenvrad.2022.106863. The level of application is "wide", since the results can be used in assessing the intake of radionuclides in agricultural products, calculating doses, developing recommendations for agricultural management, radioecological studies, etc.
		7.1 Is the provition proven? 1**) proven**; 2) rather proven; 3) rather not proven; 4) not proven	**The provision 3** is proven in the experimental part of the work in Chapter 3.12. It has been shown in Table 13 that the application of double superphosphate into the soil of the Kyzemshek village (Turkestan region) significantly increases

		7.2 Is it trivial? 1) yes; 2) **no** 7.3 Is it new? 1) **yes**; 2) no 7.4 Application level: 1) narrow; **2) medium;** 3) wide 7.5 Is it proven in the article? 1) yes; 2) **no**	the uranium isotopes and Ra-226 uptake by carrots. The level of application is "medium", since the results were obtained for one type of agricultural crop.
8.	The principle of reliability Reliability of sources and information provided	8.1 Choice of methodology - is justified or the methodology is described in sufficient detail 1) **yes;** 2) no	Considering that the thesis is defended within the framework of educational programm 8D05301 – Chemistry, the selected methods are entirely appropriate to the subject of the study and are presented with sufficient clarity, depth and scientific justification. The chemical and radiochemical procedures are described in sufficient detail in the thesis text.
		8.2 The results of the thesis were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies: 1) **yes;** 2) no	The reliability of the obtained results of the thesis was obtained using modern methods of scientific research such as sequential extraction, alpha spectrometry method with preliminary radiochemical separation, simultaneous thermal analysis, k_0-INAA analysis, modern methods of vegetation experiment and statistical analysis.
		8.3 Theoretical conclusions, models, identified relationships and patterns have been proven and confirmed by experimental research (for areas of	Theoretical conclusions, identified patterns have been proven and confirmed by experimental research. A vegetation experiment was carried out

		training in pedagogical sciences, the results have been proven on the basis of a pedagogical experiment): 1) **yes;** 2) no	to identify the biological availability of natural radionuclides depending on the fertilizers applied. Sequential extraction protocol was applied to analyse the natural radionuclides bioavailability. The author used modern methods of sample radiochemical preparation for alpha spectrometry measurement in the study.
		8.4 Important statements are confirmed / partially confirmed / not confirmed by references to current and reliable scientific literature	Important statements are **confirmed** by references to relevant scientific literature.
		8.5 Used literature sources are sufficient/not sufficient for a literature review	The list of references in the thesis consists of 176 references, of which 115 are used in the literature review. The references are presented as current scientific literature. The literature sources are **sufficient** for a literature review.
9	Practical value principle	9.1 The thesis has theoretical value: 1) **yes;** 2) no	The relevance of the study is determined by the formation of soil pollution as a result of the use of fertilizers and ameliorants in agriculture, which contribute to the introduction of natural radionuclides into the environment. The theoretical significance of the study is in the comprehensive study of the "soil-plant" system. As a result of the studies, the patterns of behavior of natural radionuclides in the soils of the Almaty and Turkestan regions were studied and the values of their absorption by carrot and radish were established depending on the application of various fertilizers.
		9.2 The thesis is of practical importance and there	Information about the natural radionuclides content

		is a high probability of applying the results obtained in practice: 1) **yes;** 2) no	in agricultural products is necessary for the correct assessment of the levels of radiation exposure of the population and biota objects. The practical significance of the work lies in obtaining quantitative parameters of the content and distribution of natural radionuclides in the "soil-agricultural plant" system using modern chemical technologies for conducting analytical work. The obtained values of the natural radionuclides transfer factors can be used as parameters of mathematical models for assessing their concentrations in agricultural products, which is very important to developing recommendations for the use of fertilizers in agriculture for the Almaty and Turkestan regions. In addition, the results of the study can be used to assess the consequences of using fertilizers in agriculture.
		9.3 Are the practice suggestions new? 1) **completely new**; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The results obtained in laboratory conditions are a unique source for choosing methods for studying the characteristics of radionuclide distribution in the environment. It is obvious that the diversity of physical and chemical properties of the objects under study require careful methodological development, which is the basis for the reliability of the results obtained. The conducted complex of analytical works contributes to the development of recommendations for conducting studies of radionuclide migration in the "soil-plant" system depending on various edaphic factors.
10.	The quality of writing and design	Academic writing quality: 1) **high**;	The thesis is written competently, the quality of academic writing is high, although there are typos

		2) average; 3) below average; 4) low.	and unfortunate expressions.
11.	Notes on a thesis	1. The section "research methods" on page 8 describes the methods of analysis, but not the study itself. It is not clear whether the study was conducted in natural conditions or using vegetation methods. There is no description of the statistical approaches used, as well as the general methodology of the study. 2. Page 12. References [13] and [12] are not listed sequentially. 3. The methodology of fractionation and bioavailability is poorly described. In paragraph 2.8 Sequential extraction procedure is given. It is described: "To analyse the fractionation and bioavailability of uranium, a sequential extraction protocol was applied." Question: was there a different procedure for other radionuclides? If so, which one? 4. Figure 20 pp. 55-56. The figure is torn into 2 pages, which complicates perception. 5. Table 12 page 71, Table 13 page 73. The numbers are given with different digits after the decimal point. For example, 1 ± 0.3, it is correct to write 1.0 ± 0.3 6. Page 75. "Despite that application of fertilizers could lead to the change in the geochemical distribution of natural radionuclides in soil, the TF value was not more than 1." There is no explanation why the transfer factors are compared with the value 1. All values in Figure 29 are less than 0.2. Comparison of the data with 1 becomes unclear.	
12.	Scientific level of the doctoral student's articles on the topic of research (in case of defense of the dissertation in the form of a series of articles, the official reviewers comment on the scientific level of each article of the doctoral student on the topic of research)	The main results on the theme of the thesis are presented in 11 publications: one of them in an international peer-reviewed journal non-zero impact factor according to the Web of Science; three articles in scientific journals recommended by the Committee for Quality Assurance in the Field of education and Science of the Ministry of Education and Science of the Republic of Kazakhstan; six abstracts at international conferences; one monograph.	

13.	Decision of the official reviewer (pursuant to paragraph 28 of the present Model Regulations)	Summarizing the consideration of the scientific research of Nursapina Nurgul Armankyzy, it should be noted that the above comments do not significantly affect the overall positive assessment of the scientific results and its practical significance. The work gives the impression of a completed scientific work with interesting scientific and practical conclusions, which, importantly, form the basis for further research. All the tasks are solved in the thesis. Thus, in terms of its relevance, the volume of work, scientific and practical significance, the thesis fully meets the requirements. The author Nursapina Nurgul Armankyzy deserves to award the degree of Doctor of Philosophy (PhD) or Doctor of Specialization

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Certify a signature

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