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THE EFFECT OF IONIZING GAMMA RADIATION ON C3 AND C4 TYPE PLANTS OF PHOTOSYNTHESIS

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Abstract. The effect of ionizing gamma rays at different doses on wheat (*Triticum durum*), barley (*Hordeum vulgare*) and corn (*Zea mays indentata*) plants and their various parameters was studied. In studies conducted using Electron Paramagnetic Resonance (EPR) spectroscopy, paramagnetic centers were studied in the root organs of wheat and corn seeds irradiated with control and different doses of ionizing gamma rays. In addition, cytogenetic analyses were performed on the seedlings of these plants, and chromosome aberrations were detected. Analysis of the obtained results confirmed the consistent and reliable results. The germination dynamics of seeds irradiated with control and gamma radiation was determined. During the study of the effect of gamma radiation on cereals, the study of biophysical and cytogenetic parameters in them showed that there is a regularity in the obtained results.

Keywords: *Photosynthesis, cytogenetic analyse, ionizing gamma radiation, C3 and C4 plants, Electron Paramagnetic Resonance Spectroscopy.*

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1. Introduction

Numerous studies have been conducted to investigate the effects of various stress factors on living systems, such as radioactive radiation, different concentrations of salt solutions, ultraviolet (UV) radiation and gamma radiation (Nasibova *et al*., 2013, 2021a, 2021b, 2023). The impacts of these stress factors, both individually and synergistically, on living systems have been examined and the nature of synergistic stress has been explained (Khomutov *et al*., 2014; Kazimli *et al*., 2022; Aliyeva *et al*., 2023). Research conducted using Electron Paramagnetic Resonance (EPR) in this field has yielded important and practical results (Nasibova *et al*., 2015; Nasibova, 2019; Amrahov *et al*., 2023). In addition to plant systems, experiments have also been carried out on certain microorganisms and animal organisms exposed to the aforementioned stress factors (Khalilov *et al*., 2008, 2022; Aberuomandi *et al*., 2017; Montazersaheb *et al*., 2023; Hasanzadeh *et al*., 2017). It has been determined that exposure to various stress factors

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results in structural changes in plants, animals and microorganisms (Maleki Dizaj *et al*., 2021; Kavetskyy *et al*., 2019).

This paper presents a comparison of the biophysical and genetic parameters in wheat (*Triticum durum*), barley (*Hordeum vulgare*) and corn (*Zea mays indentata*), representing C3 and C4 types of photosynthesis, under control and gamma radiation exposure.

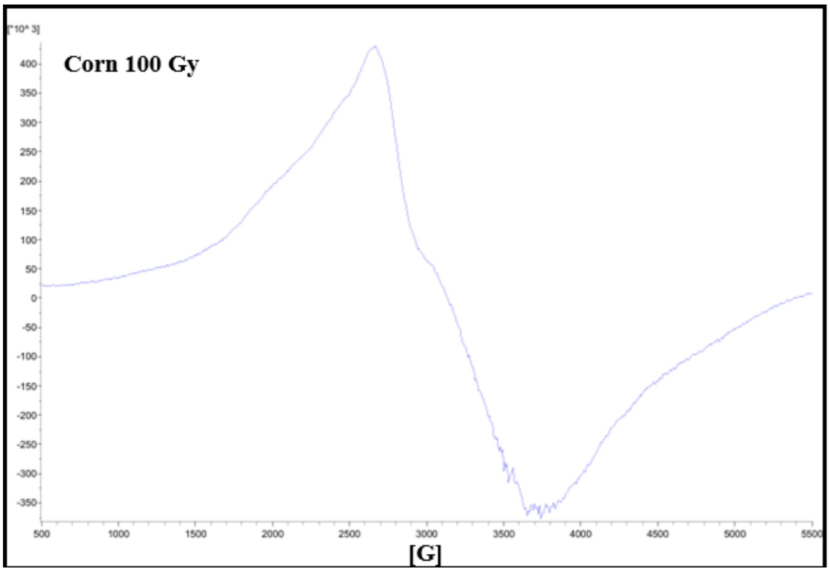
2. Materials and Methods

The subjects of the research were irradiated with gamma radiation using the URI - Gamma 25 device. The spectra of the root organs were recorded using Electron Paramagnetic Resonance (EPR) spectroscopy. The spectra of the samples were normalized per unit mass.

Approximately 40-50 ml of distilled water was added to the plant seeds placed in Petri dishes and the seeds were kept at room temperature for about 24 hours. After washing, the seeds were germinated in a thermostat at a temperature of 24-25°C. In the next step, the germinated seeds were fixed in Carnoy's fixative (six parts absolute ethanol, three parts chloroform and one part acetic acid). The germinated seeds of barley, wheat and corn were cut into 1-1.5 mm pieces. The germinated seeds were then fixed.

3. Result and Discussion

The root organs of the germinated plant seeds were studied using the EPR method and the signals that appeared were monitored. It was determined that the amplitudes of the signals varied depending on the radiation dose (Kavetskyy *et al*., 2022).



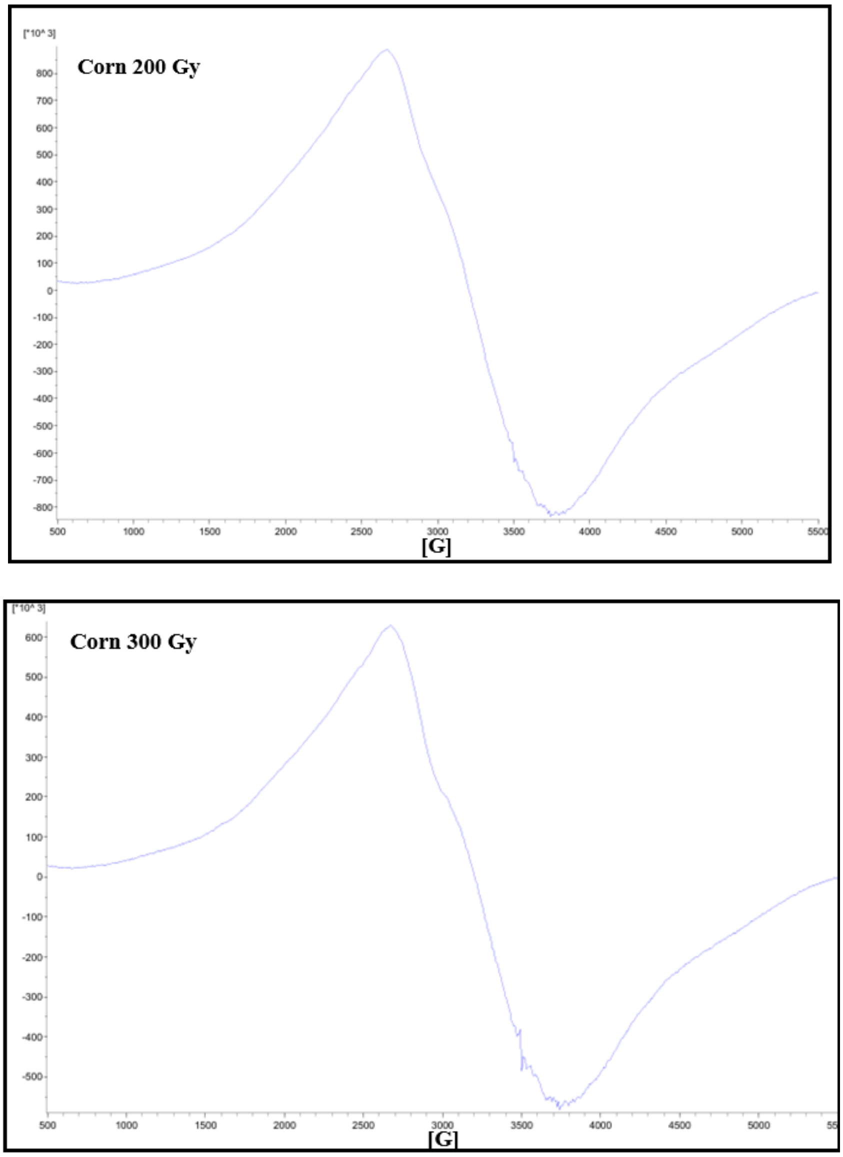
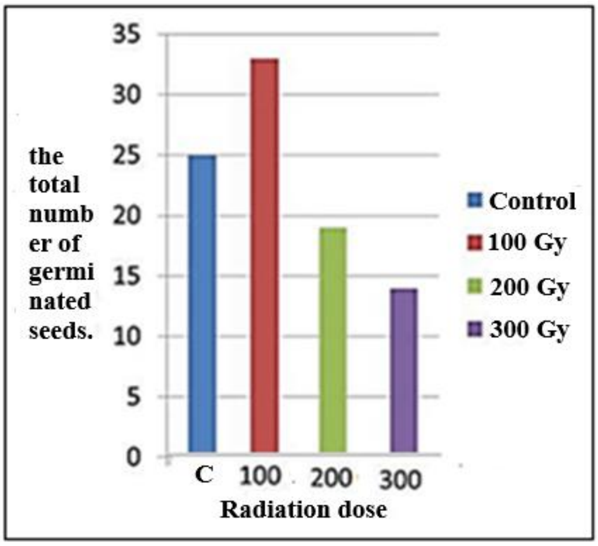


Figure 1. EPR signals of root organs of corn seeds irradiated with different doses of gamma radiation

It was observed that with an increase in the radiation dose, the amplitudes of the free radicals in the root samples grew accordingly (Figure 1).

Subsequently, the germination dynamics of control and gamma-irradiated barley (*Hordeum vulgare*), wheat (*Triticum durum*) and corn (*Zea mays indentata*) seeds were studied and their graphs were plotted (Figures 2, 3).



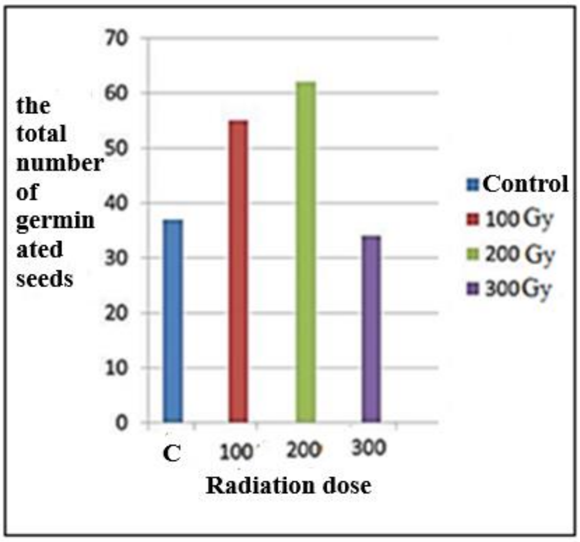


Figure 2. Germination dynamics of barley (*Hordeum vulgare*) and wheat (*Triticum durum*) seeds

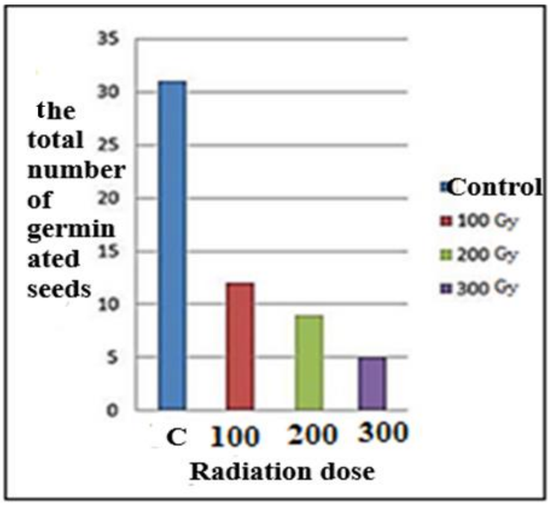


Figure 3. Germination dynamics of corn seeds (*Zea mays indentata*)

4. Conclusion

It is clear from the figure that in C3 plants, such as the barley sample studied, gamma radiation at a dose of 100 Gy caused a significant increase in the number of germinated seeds compared to the control samples. However, doses of 200 Gy and 300 Gy of ionizing radiation resulted in a noticeable decrease in the number of germinated seeds. In the C3 plant wheat sample, a dose of 100 Gy increased the germination percentage of wheat seeds compared to the control samples. A 200 Gy dose of ionizing radiation further stimulated germination, whereas a 300 Gy dose decreased the germination percentage. For C4 plants, such as the corn sample studied the 100 Gy, 200 Gy and 300 Gy doses of radiation led to a corresponding decrease in germination percentage compared to the control.

The next phase of the study involved cytogenetic analysis. Using cytogenetic analysis, changes in the chromosomal apparatus were identified, particularly abnormalities in the number of chromosomes and structural rearrangements.

The cytogenetic analysis of these seeds was carried out. The cytogenetic analysis of the seeds of barley (*Hordeum vulgare*), wheat (*Triticum durum*) and corn (*Zea mays indentata*) is presented in Table 1.

Table 1. Cytogenetic analysis of barley (*Hordeum vulgare*)

No	**Samples**	**Total number of seed roots**	**Number of cells in prophase (P)**	**Number of cells in metaphase (M)**	**Number of cells in anaphase (A)**	**Number of cells in telophase (T)**	**Total number of cells analyzed**
1	**Barley-Control**	15	32	16	11	6	322
2	**Barley-100 Gy**	10	39	19	13	7	266
3	**Barley-200 Gy**	12	36	17	10	8	278
4	**Barley-300 Gy**	10	12	6	3	1	204
5	**Wheat-Control**	16	29	22	14	8	431
6	**Wheat-100 Gy**	10	11	6	7	4	393
7	**Wheat-200 Gy**	8	6	5	3	5	382
8	**Wheat-300 Gy**	5	5	3	2	2	298
9	**Corn-Control**	15	32	16	11	6	322
10	**Corn-100 Gy**	10	39	19	13	7	266
11	**Corn-200 Gy**	12	36	17	10	8	278
12	**Corn-300 Gy**	10	12	6	3	1	204

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