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STUDY OF THE EFFECT OF RADIATION AND DROUGHT STRESS ON SOME PHYSIOLOGICAL AND TECHNOLOGICAL FEATURES IN VUGAR DURUM WHEAT GENOTYPE

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Abstract: The study aimed to compare the changes in physiological parameters, product components and grain quality in Vugar durum wheat genotype (*Triticum durum Desf*.) exposed to gamma radiation before sowing in drought and irrigated variants.

It was found that irradiation of seeds with radioactive rays increased their chlorophyll synthesis in drought conditions. The number of carotenoids remained the same for the irrigated and drought variants at a radiation dose of 10 Gy. In this case, a radiation dose of 10 Gy compensates for the drought effects. In the irrigated variant, the increase in gamma radiation dose leads to a linear decrease in the amount of proline compared to the control plant. In the drought variant, the amount of proline decreased by 50% at a dose of 50 Gy compared to the control sample and increased by 2.75 times at 10 Gy. This result can be considered as the elimination of the effect of drought stress during the joint effects of drought and radiation stresses. Although the increase in gamma radiation affected some physiological parameters, it did not significantly affect the grain quality and the product components.

Keywords: gamma radiation, drought, durum wheat, photosynthetic pigments, proline, spike elements, technological characteristics of the grain

1. Introduction

One of the many application fields of nuclear technology is agriculture. This technology is used in agriculture for various purposes. Ionizing radiation is also used to increase the therapeutic properties of medicinal plants, increasing productivity, obtaining better quality products, obtaining plant genotypes that are more resistant to various stress factors and diseases, and so on [1, 11]. Some authors suggest that gamma radiation can also be used to change the physiological characteristics of plants [4, 6, 7, 9].

Other studies show that irradiation of wheat seeds reduces the length of the root and stem during its development [3]. Depending on the radiation dose, radioactive radiation has different effects on the morphology, anatomy, biochemistry and physiology of plants [10]. These effects result in changes in plant metabolism and cell structure. For example, enlargement of thylocoid membranes, changes in photosynthesis, modulation of the antioxidant system, and accumulation of phenolic compounds. Today, mutations have become a popular method in plant breeding. With this method, it is possible to obtain genotypes with specific characteristics [5].

The study aimed to compare the changes in physiological parameters, product components and grain quality in Vugar durum wheat genotype (*Triticum durum Desf*.) exposed to gamma radiation before sowing in drought and irrigated variants.

2. Materials and methods

Dried seeds from Vugar durum wheat genotype (*Triticum durum Desf.*), selected as the object of study were irradiated at two different radiation doses of 10Gy and 50Gy. The irradiation process was carried out using of Co-60 isotope radiation source in RUXUND-20000 device in "Isotopic Radiation Source" Scientific-Experimental Complex of the Institute of Radiation Problems of ANAS. The power of the source during that period was 0.342 Rad/sec.

Irradiated seeds (10Gy and 50Gy) and control plant samples (0 Gy) were planted in the open field in the experimental field at the Agricultural Research Institute. The sown area is divided into two parts, one irrigated and the other arid. The number of green pigments, carotenoids and proline were determined in the samples taken from the green masses of these plants.

The number of chlorophylls and carotenoids was determined using the Lichtenthaler (1987) [8] method.

Proline was determined based on Bates L. et. al. (1973) [2].

At the end of the vegetation period of the plants, the product components were determined on the fully ripe wheat-ears.

After the harvest, a grain quality analysis was performed.

3. Results and discussion

As can be seen from Figure 1a, in the irrigated variant, the amount of chlorophyll a and chlorophyll b in the leaves decreased due to radiation. At a dose of 10 Gy, the amount of chl (a+b) is reduced by 42% compared to the control plant. This change is 33% at a dose of 50 Gy. The decrease in carotenoids was higher than in chl (a+b). Carotenoids were reduced by 40% at 10 Gy and 50 Gy compared to the control plant. Dose dependence was observed. chl (a+b)/carot. did not change in the radiation exposed variants. Since both chl a and chl b are approximately equally reduced by the effects of radiation, the chl (a+b)/carot. ratio is almost unchanged. There is a slight decrease in the chl a/b ratio. This is because that chl a was more sensitive to radiation than chl b.

As can be seen from Figure 1b, if we compare the results for the 0 Gy, 10 Gy and 50 Gy radiation doses in the drought variant, we'll see that there is an approximately 17% decrease in the amount of chl a due to radiation. If we compare the results for all three radiation doses taken from the drought area with the irrigated variant, we'll see that the amount of chl a in the 0Gy drought variant is 25% lower than in the 0Gy irrigated variant, while the amount of chl a in the 10 Gy and 50 Gy doses remains approximately the same.

The amount of Chl b increased by 35% and 40%, respectively, in the drought variant for 10 Gy and 50 Gy radiation than the irrigated variant.

This can be considered as a process that took place under the influence of radiation. That is, irradiation of seeds with radioactive rays increased their chlorophyll synthesis in drought conditions. An increase in the amount of chlorophyll and carotenoids was also observed in a study conducted by Sumira J., Talat P. et al. [13].

Radiation-dependent changes in the number of carotenoids for the arid area were almost not observed. However, comparing the results for the 0 Gy, 10 Gy, and 50 Gy radiation doses in the drought variant with irrigated variants, we'll see the following: in the drought variant, the amount of carotenoids decreased by 48% at 0Gy compared to irrigate one, at 50 Gy, the decrease was 30%. At 10 Gy, the change was very small. If we do not take this into account, we can say that the number of carotenoids at 10 Gy for irrigated and a drought variant has not changed. In this case, the radiation dose of 10 Gy compensates for the drought effects.

Figure 2 shows the change in the amount of proline, an osmoprotective compound for both irrigated and drought variants, due to gamma radiation. As can be seen, the increase in gamma radiation dose in the irrigated variant leads to a linear decrease in the amount of proline compared to the control plant. This can be explained by the fact that radiation disrupts amino acid synthesis and reduces the number of compounds that initiate proline.

In the drought variant, a different result is observed. At a dose of 50 Gy, the amount of proline decreased by 50% compared to the control plant, while increased by 2.75 times at 10 Gy. Given that proline is not only an osmoprotective but also an antioxidant, this result can be considered as the elimination of the effects of drought stress by radiation during the combined effects of drought and radiation stresses.

There are several literature materials on the increase of the resistance to other stresses after exposure to one abiotic factor. For example, the processing of seeds with radioactive rays and various chemicals can lead to an increase in the resistance of plants to diseases, drought, heavy metals, salinity, high temperatures, cold and other abiotic stresses during the subsequent growth of plants.

The results we obtained are consistent with this literature material. Such effects, which occur when plants are exposed to several stresses together, are called cross-adaptation. It is shown that one of the main reasons for this is the multifunctionality of stress protection systems (for example, the antioxidant system) [14].

As it is known, cross-adaptation means the formation of resistance to the influence of another stress factor after the weak influence of one stress factor. One of the main reasons for this is that multifunctional stress protection systems (such as the antioxidant system) [12, 15].

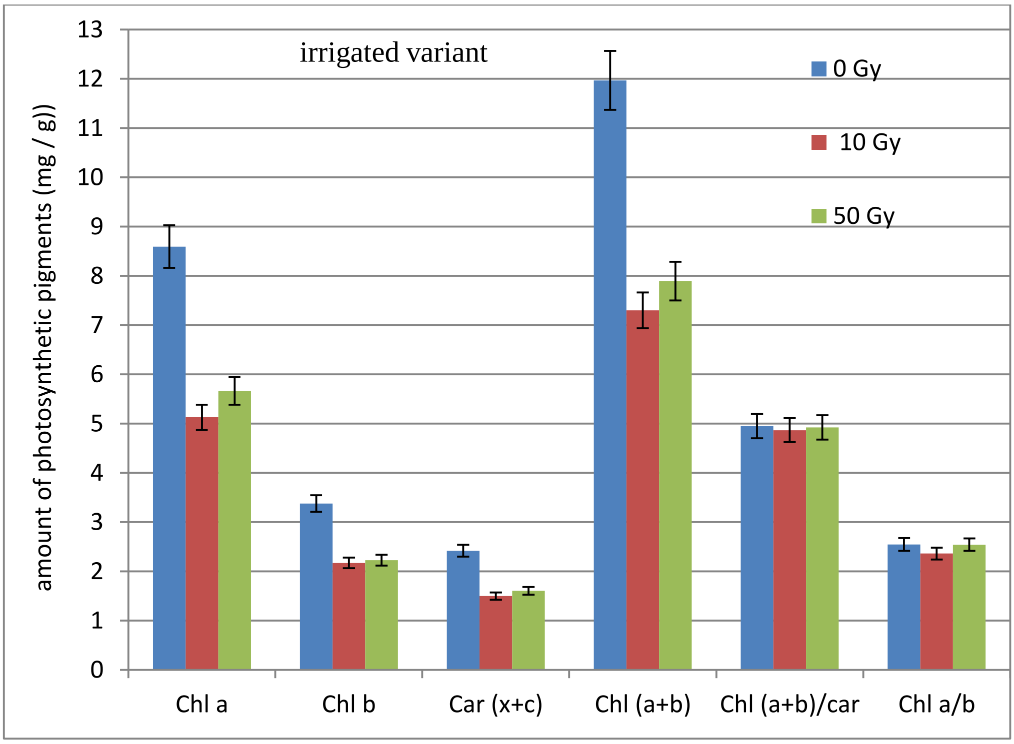

Fig. 1a. Effect of gamma radiation on the number of pigments in Vugar durum wheat genotype (Triticum durum Desf.) planted in the irrigated areas.

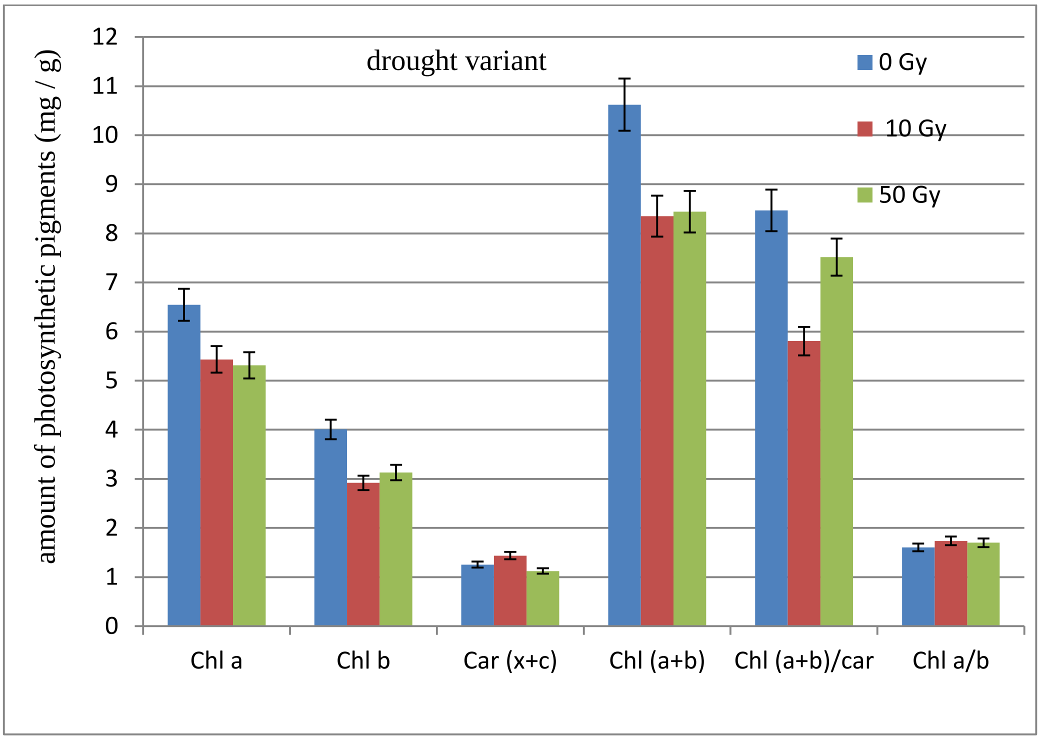

Fig. 1b. Effect of gamma radiation on the amount of pigments in Vugar durum wheat genotype (Triticum durum Desf.) planted in the drought area.

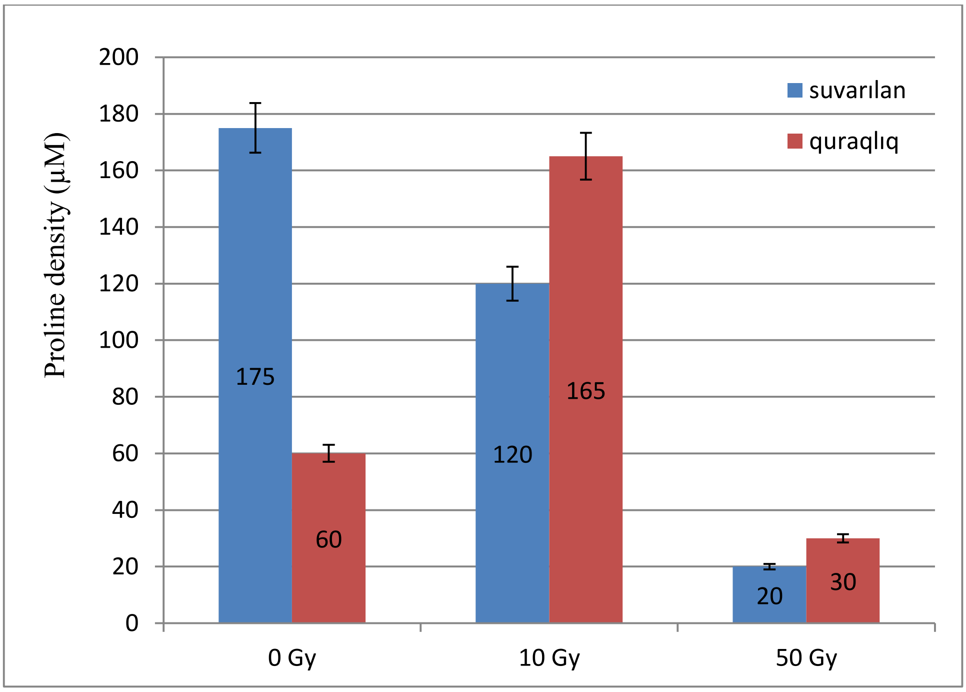

Fig. 2. Changes in the number of proline depending on the radiation dose in Vugar durum wheat genotype (Triticum durum Desf.), planted in the irrigated and drought areas.

Table 1 shows the technological quality of grain depending on the radiation dose in Vugar durum wheat genotype (Triticum durum Desf.) for both irrigated and drought variants.

First of all, let's make a comparative analysis of the quality of grain formed in plants exposed to gamma radiation doses of 10 Gy and 50 Gy than control plants for irrigated variants. As shown in the table, the vitreousness did not depend on the dose. The amount of gluten was reduced at a dose of 50 Gy compared to the control plant. Although the deformation coefficient of gluten (DCG) was close to the control variant at a dose of 10 Gy, it increased at a dose of 50Gy. Sedimentation equally decreased in the irradiated samples compared to the control plant. The amount of protein was increased at a radiation dose of 10 Gy compared to control plants and it decreased at a radiation dose of 50 Gy. It was found an increase in the mass of 1000 grains at doses of 10Gy and 50Gy d compared with the control plant.

If we do not take into account the slight differences between the parameters of the technological quality of the grain in the drought variant, we can say that the effect of radioactive radiation was not noticed.

When comparing the drought and irrigated variants, respectively, the change tendency at 10 Gy and 50 Gy was maintained as in 0 Gy. The effect of the radiation did not make any difference.

Table 2 shows the results of the effect of gamma radiation on product components depending on the radiation dose in Vugar durum wheat genotype (Triticum durum Desf.) for both irrigated and drought variants. As can be seen, there was no change in the linear dimensions in length and width of the spike at a dose of 10 Gy compared to the control plant in the irrigated variants. Due to the effects of radiation, the number of spikes in the spike has increased slightly. At a dose of 10 Gy, the weight of the spike was reduced by 33%. At a dose of 50 Gy, the mass of the spike got the value close to the control plant. Compared to control plants, the number and weight of grains in the spike increased slightly at doses of 10 Gy and 50 Gy of gamma radiation. Considering that slight changes are within error, we can say that the effect of radiation on product components in the irrigated area was not observed. The same can be said for the drought area.

Although the increase in gamma radiation affected some physiological parameters, it did not significantly affect the grain quality and the product components.

Table 1

Technological quality indicators of grain depending on the radiation dose in Vugar durum wheat genotype (*Triticum status Desf.*)

№	Experiment variant		Vitreousness, %	Gluten, %	DCG, the elasticity of the dough, c.u.	Sedimentation, ml	Protein, %	1000 grains mass, gr
1	0Gy	Irrigated	100	32.8	104.7	16.5	14.797	32.8
		Drought	100	31.2	100.4	13.5	13.784	31
2	10Gy	Irrigated	100	33.2	105.8	15	15.203	34.2
		Drought	96	30.8	92.8	15	15.203	32.4
3	50Gy	Irrigated	100	29.6	108.4	15	14.392	36.4
		Drought	100	30.4	101.8	15	14.797	28.6

Table 2

Effect of radiation dose on product components in Vugar durum wheat genotype (Triticum durum Desf.)

№	Experiment variant		Spike width, cm	Spike length, cm	Number of spikes, number	Spike mass, gr	Number of grains in spike, number	Grain mass in spike, gr
1	0Gy	Irrigated	1.56	6.56	14	2.42	44	1.7
		Drought	1.34	5.62	14	1.68	35	1.18
2	10Gy	Irrigated	1.56	6.58	15	1.67	45	1.84
		Drought	1.46	6.08	15	1.69	37	1.11
3	50Gy	Irrigated	1.54	6.6	15	2.64	46	2.02
		Drought	1.20	5.36	13	1.65	33	1.13

Conclusion: A dose of 50Gy compared to a 10Gy dose of radiation resulted in a sharp decrease in the amount of photosynthetic pigments and proline in the plants affected by the irrigated and drought stresses.

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ИЗУЧЕНИЕ ВОЗДЕЙСТВИЯ СТРЕССОВЫХ ФАКТОРОВ РАДИАЦИИ И ЗАСУХИ НА НЕКОТОРЫЕ ФИЗИОЛОГИЧЕСКИЕ И ТЕХНОЛОГИЧЕСКИЕ ХАРАКТЕРИСТИКИ В ГЕНОТИПЕ ТВЕРДОЙ ПШЕНИЦЫ ВУГАР

Дж.Р. Оруджева, Т.И. Аллахвердиев

Резюме: Цель исследования изучение изменений физиологических параметров, компонентов производительности и качества зерна твердой пшеницы Вугар гамма-облученных до посева в вариантах засухи и орошения.

Выявлено, что облучение радиоактивными лучами усилил синтез хлорофилла в них. При дозе излучения 10Gy для вариантов поливных и засухи количество каротиноидов остался одинаковым. В этом случае доза излучения 10Gy компенсировал действие засухи. В варианте поливных по сравнению с контрольным растением повышение дозы гамма-излучения приводит к линейному снижению количества пролина. А в варианте засухи при дозе облучения 50Gy количество пролина по сравнению с контролем снизился на 50%, тогда как при дозе облучения 10 Gy повысился в 2,75 раза. Этот результат можно объяснить, как устранение стресса засухи радиацией при совместном воздействии обоих стрессовых факторов - засухи и радиации. Несмотря на то, что увеличение дозы гамма-облучения подействовало на некоторые физиологические параметры зерна, но на качественные показатели и компоненты продуктивности значительно не повлияло.

Ключевые слова: гамма-облучение, засуха, твердая пшеница, фотосинтезирующие пигменты, пролин, элементы колоса, показатели технологической характеристики зерна

VÜQAR BƏRK BUĞDA GENOTİPİNDƏ RADİASİYA VƏ QURAQLIQ STRESLƏRİNİN BƏZİ FİZİOLOJİ VƏ TEXNOLOJİ ƏLAMƏTLƏRƏ TƏSİRİNİN ÖYRƏNİLMƏSİ

C.R. Orucova, T.İ. Allahverdiyev

Xülasə: Tədqiqatın məqsədi toxumları səpindən əvvəl qamma-şüalanmanın təsirinə məruz qalmış Vüqar bərk buğda (*Triticum durum Desf.*) genotipində fizioloji parametrlərin, məhsul komponentlərinin və dənin keyfiyyətində baş verən dəyişikliklərin quraqlıq və suvarılan variantlarda müqayisəli öyrənilməsi olmuşdur.

Müəyyən edilmişdir ki, radiaktiv şüalarla toxumların şüalandırılması onlarda quraqlıq şəraitində xlorofill sintezini artırmışdır.10 Gy şüalanma dozasında suvarılan və quraqlıq variantlar üçün karotinoidlərin miqdarı eyni qalıb. Bu halda da 10 Gy şüalanma dozası quraqlığın təsirini kompensasiya etmiş olur. Suvarılan variantda nəzarət bitkisi ilə müqayisədə qamma-şüalanma dozasının artması prolinin miqdarının xətti azalmasına səbəb olur.Quraqlıq variantda isə 50Gy şüalanma dozasında prolinin miqdarı kontrola nisbətən 50% azaldığı halda, 10 Gy şüalanmada isə 2,75 dəfə artmışdır. Bu nəticəni quraqlıq və radiasiya stresslərinin birgə təsiri zamanı radiasiyanın quraqlıq stresinin təsirini aradan qaldırması kimi qəbul etmək olar.

Baxmayaraq ki, qamma-şüalanmanın artması bəzi bəzi fizioloji parametrlərinə təsir göstərsə də dənin keyfiyyət göstəricilərinə və məhsul komponentlərinə əhəmiyyətli təsir etməmişdir.

Açar sözlər: qamma-şüalanma, quraqlıq, bərk buğda, fotosintezedici piqmentlər, prolin, sünbül elementləri, dənin texnoloji əlamət göstəriciləri