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THE STUDY OF BIOMETRIC INDICATORS OF THE BEAN PLANT IN THE CONDITION OF SALT AND RADIATION STRESS

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Abstract: The present work has been devoted to the study of biometric indicators of vegetative organs of bean plant in the conditions of separate and joint effects of different concentrated salt and γ-radiation with different doses. It has been established that though salt and radiation stresses have to inhibit effect both on the growth of bean plant and on biomass collection separately in certain concentrations and doses, they have a stimulating effect on the mentioned processes in the specific combination of salt concentration and radiation dose. It is considered that the irradiation of seeds in certain doses before sowing can protect the plant from the damaging effect of salt stress in certain concentrations.

Keywords: bean, salt stress, radiation stress, biometric indicators

1. Introduction

The plants are exposed to extreme environmental factors throughout their ontogenesis. It has been established that as the physiological-biochemical processes occurring in organisms as a result of slowing the growth of plants due to the effect of stress factors weaken, their productivity and economic indicators decrease [1, 2, 3, 7]. Based on the results of numerous studies, it can be said that in stressful conditions, plants try to protect themselves from the effect of stress by making certain changes in the metabolism [5, 6, 8, 9, 10, 11].

The main purpose of this work is to study the effects of different concentrations of salts and gamma-rays with different doses on the biometric indicators of the vegetative organs of the bean plant at the beginning of its growth.

2. Materials and Methods

Dried bean seeds (Sevinj sort) taken as the object of research, were irradiated at the doses of 1, 5, 10, 50, 100 and 200 Gy. The irradiation process was carried out using the ^{60}Co-source in the RUXUND-20.000 radiation device at the "Isotopic Radiation Source" Scientific-Experimental Complex of the Institute of Radiation Problems.

In the laboratory conditions, both irradiated and control seeds were seeded in Petri dishes with 20 seeds in each dish and the obtained 3-day sprouts were transferred to 400 ml vegetation containers in two variants. At this time, the sprouts obtained from the non-irradiated and irradiated seeds were transferred to the same volume glass containers filled with salt solutions with 1, 5, 10, 50, 100 and 200 mM concentrations accordingly, and covered with a black coating (Figure 1).

In control samples, sprouts were transferred to glass containers with ordinary tap water instead of salt solutions. The investigation of biometric signs of plants has been carried out with the help of ordinary geometric methods.

The statistical processing of the results was carried out according to Lakin [4].

Fig. 1. Cultivation of bean plant in separate variants

3. Results and Discussion

It has been established from the observations and measurements that the changes in the trunk and root systems of the plant occur depending on the radiation dose and salt concentration. As it is seen from Figure 2, while the growth of the trunk is slowing down at 200 Gy radiation dose, the root system of plants is more grown than control. In this case, the length of the primary root is 0.5 times shorter than the control, while lateral roots grow well and increase their length by about 2 times. The length of the trunk was ~ 2.5 times shorter than the control (Table 1). As it is seen from Table 1, the interesting view has been observed at 5, 10, 50, 100 Gy doses. The radiation dose of 5 Gy had a more slowing effect on the growth of both the root and the trunk than the radiation dose of 10 Gy.

Fig. 2. Morphogenesis of bean plant at different radiation doses

In contrast, while the length of the roots is the same as the control in both variants at 50 and 100 Gy radiation doses, there are 54% and 70% differences in the length of the trunk, respectively, than the control.

One of the most important issues in biometric studies is the separate identification of the masses of the plant and its organs and their comparative analysis.

It is clear from the results of the mass of the individual organs of the plant that radioactive radiation can dramatically increase biomass collection in leaves at 1 Gy dose. An increase in the mass of roots is observed at the radiation doses of 50 and 100 Gy. The total mass of the plant was recorded at 5 and 50 Gy radiation doses.

Table 1.

The effect of radioactive radiation on the biometric indicators of bean plant

		L_{leaf} (mm)	**L_{hull} (mm)**	**L_{root} (mm)**	**$L_{whole\ plant}$ (mm)**	**M_{leaf} (mg)**	**M_{hull} (mg)**	**$M_{whole\ plant}$ (mg)**
Radiation stress	Control	25± 0,5	110±2,2	62±2,4	200±10	11±0,3	19±0,5	198±9,9
	1 Gy	36±0,7	140±5,6	80±4	220±8	16±0,6	22±0,8	209±10,4
	5Gy	31±0,2	165±4,9	55±2,2	220±9	13±0,6	18±0,7	238±9,5
	10Gy	30±0,6	155±7,7	40±2	195±7,8	12±0,6	14±0,4	187±9,3
	50Gy	35±0,4	95±4,7	60±3	155±7,7	13±0,5	36±1,4	243±9,7
	100Gy	26±0,7	125± 5	65±2,6	190±5,7	14±0,5	35±1,4	164±8,2
	200Gy	31±0,9	65±1,9	35±1,05	100±3	11±0,5	22±1,1	214±10,7

The next stage of the investigation was devoted to the study of plant samples cultivated in salt solutions with various concentrations.

The results show that the growth of surface vegetative organs of sprouts cultivated at 50mM, 100mM and 200mM concentrations has stopped, and the root system has grown very well. The sprouts have grown normally in the concentration of 1mM, 5mM, and 10mM (Figure 3).

Fig. 3. Morphogenesis of bean plant in different salt concentrations

Despite the fact that the growth of plants in the control variants is normal, the organisms of experimental plants are behind in terms of biomass collection. The results from this category are given in Table 2.

The results show that while salt stress accelerated the growth of the leaf and trunk in the 1, 5, 10 mM concentrations, it had a slowing effect on the growth of the root. A decrease is observed in biomass collection due to the effect of salt stress.

Table 2.

Effect of different salt concentrations on biometric indicators of bean plant

		L_{leaf} (mm)	L_{hull} (mm)	L_{root} (mm)	$L_{whole\ plant}$ (mm)	M_{leaf} (mg)	M_{hull} (mg)	$M_{whole\ plant}$ (mg)
Salt stress	Control	25±1	110±5,5	62±1,8	200±11	11±0,5	19±0,7	198±10
	1 mM	32±0,9	150±7,5	40±1,2	190±9,6	10±0,5	13±0,5	151±7
	5mM	36±1,8	127±5	43±1,7	170±6,8	9±0,2	10±0,4	176±9
	10mM	36±1,4	170±8,5	60±2,4	230±9,2	11±0,3	10±0,2	119±6

The third part of our study is devoted to the investigation of biometric indicators in salt solutions with various concentrations (1, 5, 10 mM) at 5, 50, 100 Gy radiation doses (Figure 4).

Fig. 4. Effects of different salt concentrations on biometric indicators at the same radiation doses

It has been established that the vegetative organs of bean plants cultivated in the solutions with a low dose and low concentration grow better than control. However, there is obtained completely opposite indicators from those results in salt solutions with high doses and high concentrations. In this condition, the growth in plants weakened, and the morphogenesis in the plant decreased accordingly (Table 3).

Table 3.

Effect of various irradiation doses and salt concentrations on biometric indicators of the plant.

		L_{leaf} (mm)	L_{trunk} (mm)	L_{root} (mm)	$L_{whole\ plant}$ (mm)	M_{leaf} (mg)	M_{hull} (mg)	$M_{whole\ plant}$ (mg)
Joint stresses of salt and radiation	Control	25±1	110±5,3	62±3,1	200±9	11±0,4	19±0,7	198±11
	5Gr 1mM	40±2,3	150±6	25±1,2	175±7,2	13±0,7	28±0,5	226±11,3
	5Gr 5 mM	35±1,4	140±7	50±2,3	190±7,4	10±0,4	19±0,3	176±8,1
	5Gr 10mM	25±1,3	140±5,6	70±2,5	210±8,1	7±0,1	25±0,6	142±6,8
	50Gr 1mM	55±2,4	155±6,2	35±1,2	190±7,3	30±1,4	64±1,6	299±10,9
	50Gr 5mM	37±1,8	100±3	30±0,9	130±5,6	9±0,2	29±0,6	190±6,9
	50Gr 10mM	40±2,1	110±3,3	20±0,6	130±4,8	13±0,4	19±0,3	170±7,8
	100Gr 1mM	38±1,9	100±3,5	20±0,4	120±4,2	14±0,5	27±0,8	156±6,8
	100Gr 5mM	37±1,8	122±4,8	38±1,9	160±5,9	11±0,5	20±0,6	181±9
	100Gr 10mM	33±1,3	130±6,5	25±0,8	155±5,7	11±0,3	27±1,2	115±4,9

The combination of 50 Gy and 1 mM draws more attention among the results obtained on the double stress condition. In such a condition, biomass collection has the maximum value compared to other variants. It can be assumed that a 50 Gy radiation dose can stimulate the effect of salt stress with 1 mM concentration.

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ИЗУЧЕНИЕ БИОМЕТРИЧЕСКИХ ПОКАЗАТЕЛЕЙ ФАСОЛИ В УСЛОВИЯХ СОЛЕВОГО И РАДИАЦИОННОГО СТРЕССА

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Резюме: Представленная работа посвящена изучению биометрических показателей вегетационных органов фасоли в условиях раздельного и совместного солевого и радиационного воздействия. При этом облученные в разных радиационных дозах семена фасоли были выращены в растворах соли при разных ее концентрациях. Было показано, что как солевой стресс при определенных концентрациях соли, так и радиационный стресс при определенных дозах облучения в отдельности вызывает ингибирующее действие на рост и развитие растения. При этих концентрациях соли и дозах облучения замедляется также процесс накопления биомассы. Однако при совместном действии соли и радиации в определенных концентрациях соли и дозах гамма облучения, наоборот, стимулируется рост, развитие и накопление биомассы. Предполагается, что предпосевное облучение семян в определенных дозах защищает растения от негативного воздействия соли.

Ключевые слова: фасоль, биометрические показатели, предпосевное облучение, солевой стресс.

LOBYA BİTKİSİNİN DUZ VƏ RADİASİYA STRESLƏRİ ŞƏRAİTİNDƏ BİOMETRİK GÖSTƏRİCİLƏRİNİN ÖYRƏNİLMƏSI

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Xülasə: Təqdim olunan iş lobya bitkisinin vegetativ orqanlarının müxtəlif qatılıqlı duz və müxtəlif dozalı γ-şüalanmanın ayrılıqda və birgə təsiri şəraitlərində biometrik göstəricilərinin öyrənilməsinə həsr olunmuşdur. Müəyyən edilmişdir ki, duz və radiasiya stresləri ayrılıqda müəyyən qatılıqlarda və müəyyən dozalarda lobya bitkisinin həm boyatma və inkişafına, həm də biokütlə toplanmasına ingibirləşdirici təsir göstərdiyi halda, duz qatılığının və şüalanma dozasının müəyyən kombinasiyasında, əksinə, adı çəkilən proseslərə stimullaşdırıcı təsir göstərir.Hesab olunur ki, toxumların səpindən əvvəl müəyyən dozalarda şüalandırılması müəyyən qatılıqlarda bitkini duz stresinin zədələyici təsirindən mühafizə edə bilir.

Açar sözlər: lobya,duz stersi, radiasiya stresi, biometrik göstəricilər