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Study of changes formed as a result of the effect of gamma radiation on cotton varieties' seeds

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Abstract
In addition to hybridization, the article focuses on the acquisition of primary mutant forms for selection by experimental mutagenesis.
Each acquired mutant is selected on the basis of its superiority over control forms with one or more valuable traits. The most valuable of these characteristics in cotton are productivity, early maturity, high technological qualities and resistance to pests and diseases. Necessary research work has been carried out in our country in this direction.
Recent studies have shown that different doses of radiation have different mutational effects. Intense radiation has a higher radiation effect than low radiation. This can be explained by the fact that the cell undergoes profound changes under the influence of strong radiation, resulting in an increase in the number of mutations. The seeds and other organs of plants were affected by high doses of radiation. In this case, it is possible to obtain a large amount of hereditary variability by mutation without causing very profound disturbances in the growth, development and reproduction of plants.

Keywords: cotton, mutagenesis, sort, sterile, mutation, fiber output

Introduction

In modern times, the acquisition of viable valuable materials by artificial methods has been found to be more important for plant breeding. Many methods have already been developed to obtain artificial mutations. They are based on the effects of various physical and chemical factors called mutagens on organisms. The modern breeder mainly uses different types of radiation and the influence of several physical factors. As a result of the influence of these factors, the variability of mutations in plants can be sharply increased. As a result of mutations in plants, new valuable features can be formed that have never been seen before in nature. From thousands of harmful and useless mutants from a large number of different primary forms, the breeder selects a rare valuable form and uses it in the creation of new varieties [Nazarov, 2003] [8].

Mutational variations in cotton obtained by experimental mutagenesis are of particular importance in mutations with high productivity and high fiber quality, which determine the economic value of the features. At the same time, along with its effect on economic values, its influence on morphological features is of great importance [Rakhmatullina, 2007] [9].

In our country, some researchers have tried to create new varieties using tools that can change the effects of both physical and chemical mutagens on plant seeds, pollen and other organs. In this regard, our research covers this area, so it helps to obtain new variables under the influence of external factors.

As a result of our research, it was concluded that experimental mutagenesis is the most effective method in obtaining starting material for selection [Makhmudov et al., 1986; Makhmudov et al., 2012] [6, 7]. High-yield, fast-growing, high-fiber cotton varieties resistant to high productivity, diseases and pests have been created the selected mutant forms, as well as hybridization. İt has been created high-yield, fast-growing cotton varieties with high fiber output and resistant to diseases and pests by conducting directed selection of obtained mutant forms as well as using them in hybridization.

Materials and Methods

Two cotton varieties obtained without self-pollination of seeds for 2 years - AzNIXI-104, AzNIXI-195 were used as research material. As for the research material two cotton varieties – AzNIXI-104 and AzNIXI-195 were used those seeds were obtained by self-pollination during 2 year. According to F.M. Mauer's systematics, the above-mentioned cotton varieties belong to the genus *Gossypium*, half-genus *Eugossypium*, specie *G. hirsutum* L., and the somatic cell has 52 chromosomes. According to the latest classification, the genus *Gossypium* L. combines 35 diploid (2n = 26) and 6 allotetraploid (2n = 52) species.

Due to the positive bio morphological, economic value characteristics and technological fiber quality of both varieties involved in the study, it is expedient to study them in more detail in various studies.

Dry seeds of AzNIXI-104 and AzNIXI-195 cotton varieties were irradiated with Co^{60} isotope at the Institute of Radiation Problems of ANAS in Baku and the reactor capacity was 430 X-rays.

Non-irradiated seeds of these varieties were taken as a control option. After irradiation, the seeds of cotton varieties were sown in the open field in the second decade of April at the Central Experimental Base of the Azerbaijan Scientific-Research Cotton Institute. Sowing was carried out in 3 repetitions according to the sowing scheme of 60 x 30 cm with 2 seeds in each sowing nest and 160 seeds were sown in each variant.

Taking into account that experimental mutagenesis did not allow dilution, a limited number of seeds (2 pieces) were sown in each sowing nest. Thus, if there will be carried out dilution, the percentage of mutation output is violated, and at the same time, plants that have changed in a positive direction, which is important for us, can be destroyed. A few days after sowing, field germination of seeds was registered. Shoots were observed every two days. Partial (25%) and mass (75%) germination of shoots was reported by options and doses. At M_1 there were recorded the periods of flowering and maturation development phases. The maturating rate of the bolls was also determined. During the study, the effect of different doses of gamma rays on the height and development of the cotton plant was studied in the phases of mass budding, flowering and maturation, and this was determined by measuring 25 plants in each variant. Also, the viability of plants was studied at the end of the growing season. In the M_1 generation, experimental plants were systematically observed throughout the growing season. Sterile, fertile, etc. forms formed in plants also were recorded.

In M_1 the seeds of both modified and unmodified plants were collected separately and sown as a family in M_2. In the second year of the study, in M_2 there was conducted observation in different variants of the same type of modified plant, which were also collected separately according to the variants and studied in M_3 to determine whether the variability is inherited. In the second year of the study, changes in new characteristics were identified in the field. The seeds of this modified plant were planted in M_3 and the nature of the variables was studied. It turned out that some of them are of hereditary character. These variables were recorded as mutation variables and their quantities were determined.

Results and Discussion

The research aims are creating mutant forms with a large number of modified economic values (early maturity, high fiber quality, productivity, high fiber yield, etc.) that differ from the original varieties as a result of the effect of gamma rays on cotton seeds. A number of genotypic modification variations have been found in pre-sowing exposure to different doses of gamma rays. Thus, the shape of the bush, branching, slicing of bolls, color of leaves, etc. polygenic features varied and differed from control option [Krivosheina, 2003] [5].

The presence of sterile, semi-sterile and chlorophyll-free plants among the modified plants in M_1 may be related to the formation of variability [Yazıcı et al., 2016] [3, 10].

As the dose of gamma rays increases, chlorophyll mutations increase. These plants are characterized by a lack of chlorophyll. The leaves of the plants turn green until the 2-3rd main leaves are formed, and the others are destroyed. It should be noted that sterile and semi-sterile plants are more common in variants of gamma radiation at doses of 20000 rad and 30,000 rad.

Among the modified plants in M_1 are fast-growing, oblong and oval boll-shaped, multi-segmented, several bolls clustered, lateral branches elongated, stem weak and strongly hairy, large inflorescence, leaves deeply incised and heart-shaped, large and plants with small bolls and scattered branches were obtained.

In different variants of the experiment, especially in doses of 5000 rad, 10000 rad, the main body is hairy, elongated, ovate, with a sharp nose, as well as shortened vertebrae and bar bodies 3, 4, even 5 walnuts gathered together, multi-slice boll, deeply sliced leaves plants were found. Plants with compact, zero-type, first and pyramidal-type branches, as well as fast-growing, high-yielding forms are of special interest for practical selection [Bogotolova, Mazenin. 20007; Balchy et al., 2020] [2, 1].

The types and amounts of variability obtained by pre-sowing influence of gamma rays into the seeds are given in Table 1.

From the data in Table 1, it can be seen that after influence of all doses of gamma rays, different types of variability occurred in plants. Among them, the bush with compact and scattered shape, that has a short stem, with numerous side branches can be noted.

Sometimes in plants, under the influence of mutagens, as a result of fascia of sympodial branches, clusters of fruit branches are formed. Thus, in a short sympodial branch sometimes dozens of small bolls are formed. Such a change occurs only under the influence of gamma rays, which is explained by the disorders that occur in the process of meiosis. During embryogenesis, these cells develop poorly and form short sympodial branches. The formation of such cluster-like sympodial branches is considered a rare inherited variability. The acute effect of mutagens was also manifested in the height of plants and there was found very tall or sharply small (deaf) plants [Dzhabbarov, 1978] [4]. Karlik forms were found only among plants belonging to the variants of the effect of doses of 10000 rad and 20000 rad on the seeds of AzNIXI-104 variety.

In some plants, large or sharp small bolls were found, which were also with very scattered bush and were mainly late maturing. Most small bolls were with compact bushes. Even pairs of bolls have been found in plants, which is one of the rare types of variability. Such symptomatic forms have been found in high doses of both mutagens.

In various experimental variants in M_1, sterile, semi-sterile, low-fertile plants were observed mainly under the influence of high doses of gamma rays.

Thus, in addition to sterile, late-ripening plants with small boll, cluster-like fruit-branched forms, which have no experimental significance in the variability caused by mutagens, plants of economic importance with large boll, compact bush, and fast-growing feature were also found.

Table 1: Types and amount of variability observed in M_1 due to the effect of gamma rays on the seeds of cotton varieties

№	Gamma radiation doses, rad	Number of changed plants, units	Type of variability (number of plants, number)											
			The shape of the bush						Qozanın forması					
			Compact	Scattered	Strongly branched plants	Fassation on the branches	Karlik	Clustered bolls	Big	Small	Located in pairs	Sterile	Semi-sterile	Fast growing
Cotton variety AzNİXİ-104														
1	0(Control)	-	-											
2	500	18	5			2			1	3				7

3	5000	22	3	2		3	1	2	3	2	2		1	3
4	10000	23	2	3	3	1	2	2	3		3	2	2	
5	20000	25	1	4	3	3	2	3	4			3	2	
6	30000	28		3	4	4	2	2	6		3	3	1	
	Total	116	11	12	10	13	7	9	17	5	8	8	6	10
Cotton variety AzNİXİ-195														
1	0(Control)	-												
2	500	11	3			1	1			2				4
3	5000	15	3				2	1		2	2		3	2
4	10000	21		2	3	2	2	2	2		3	3	2	
5	20000	25	1	4	3	3		3	3		2	4	2	
6	30000	26		5	4	3		3	4		2	3	2	
	Total	98	7	11	10	9	5	9	9		9	10	9	6

Table 2 shows the number of plants changed in M_1. It can be seen from the table that the highest variability in the total number of plants in the cotton variety AzNIXI-104 was obtained in the variant of gamma ray dose 30000 rad (23.3±3.86%), and the number of plants changed in the general variants was 12.7 ± 1.20%. was. Therefore, the variability increases as the dose of gamma rays increases.

The number of changed plants in AzNIXI-195 variety varied depending on the doses of gamma rays. In this variety, the variability was 18.1±3.28% in the 20000 rad variant, and 21.0 ± 3.66% in the 30000 rad variant.

In plants that have undergone variation in all variants, the growth and development phases were normal at the beginning of the growing season, and then sharp differences began to form. Despite the formation of normal bolls in these plants during reproductive development, most of them remained unopened at the end of the growing season, and the mature bolls were located mainly in the lower part of the sympodial branches.

Thus, different types of variability occurred in plants due to the pre-sowing effect of gamma rays, and the number of such plants varied depending on the dose of gamma rays in both varieties. It was found out that AzNIXI-104 cotton variety is considered to be the most mutable variety in terms of the number of variability. In general, no regularity was found in the variability types of both cotton varieties, and this is random. However, under the influence of different doses of gamma rays, the level of variability in both cotton varieties was found to be similar.

All variable and non-variable plants in M_1 were collected individually and sown and evaluated separately in M_2.

It is known that a wide range of hereditary variability is obtained under the influence of gamma rays, and as a result, there is a wide range of opportunities for individual selection with many valuable features [Cuchuctaban et al., 2016] [3]. In order to detect different types of variability, accurate observations were made in M_1 and M_2 from the germination phase to the full maturation phase, and the variability in M_1 was studied to be hereditary or modified. It is known that a wide range of hereditary variability is obtained under the influence of gamma rays, and as a result, there is a wide range of opportunities for individual selection with many valuable features [Cuchuctaban et al., 2016] [3]. In order to detect different types of variability, accurate observations were made in M_1 and M_2 from the germination phase to the full ripening phase, and the variability in M_1 was studied to be hereditary or modified. Therefore, a wide range of hereditary and modification variations from the pre-sowing effects of gamma rays have been studied in the study. As noted, in M_1, all plants were collected separately and sown separately as a family in the second generation.

Table 2: Variability formed in M_1 due to the effect of gamma rays on the seeds of cotton varieties

№	Gamma radiation doses, rad	AzNİXİ-104			AzNİXİ-195		
		Total number of plants in M_1, in numbers	Modified plants		Total number of plants, in numbers	Modified plants	
			number	%		number	%
1	0 (Control)	248	-	-	179	-	-
2	500	254	18	7,1 ± 1,61	191	11	5,7 ±1,68
3	5000	195	22	11,2 ± 2,26	172	15	8,7 ± 2,15
4	10000	175	23	13,1 ± 2,55	148	21	14,2 ± 2,87
5	20000	155	25	16,1 ± 2,95	138	25	18,1 ± 3,28
6	30000	120	28	23,3 ± 3,86	124	26	21,0 ± 3,66
	Total	899	116	12,7 ±1,20	772	98	12,7± 1,20

Observations in all plants show that most of the variability obtained in M_1 is not found in the M_2 generation. In plants, compact bushes with large bolls or pairs of bolls, small plants, branched bushes, are considered the dominant mutation. Other variations are splitting of the main body; sympodial branches with cluster-like cones, semi-sterile forms are considered morphosis. However, in some families, different types of variability, fast-growing, large-leaved, bloomy, long-fibered, etc. forms were found. Among the variables in M_1, pairs of bolls and small karlik plants were dominant in the generation and retained their hereditary characteristics in a 3:1 ratio.

Table 3 shows the number of families according to the variability in M_2 due to the pre-sowing effect of gamma rays on the seeds and the results for the variants as a result of maintaining this variability in M_3. As can be seen from the table, not all of the variables obtained in M_2 were mutational variables.

Table 3: Variability in M_2 and mutation in M_3 due to the effect of gamma rays on the seeds of cotton varieties

№	Gamma radiation doses, rad	Number of families studied, number	Changed families in M_2		M_3-də mutasiya baş verdiyi ailələr	
			Number, numbers	%, (x ± S_x)	Number, numbers	%, (x ± S_x)
1	2	3	4	5	6	7
AzNİXİ-104						
1	0(Control)	248	-	-	-	-
2	500	254	18	7,1 ± 1,61	14	5,5 ± 1,43
3	5000	195	22	11,2 ± 2,66	17	8,7 ± 2,02
4	10000	175	23	13,1 ±2,55	18	10,3 ± 2,30
1	2	3	4	5	6	7
5	20000	155	25	16,1 ± 2,95	21	13,5 ± 2,74
6	30000	120	28	23,3 ± 3,86	22	18,3 ± 3,53
	Total	899	116	12,9 ±1,17	92	10,2 ± 1,01
AzNİXİ-195						
1	0(Control)	179	-	-	-	-
2	500	191	11	5,7 ± 1,68	7	3,7 ± 1,36
3	5000	172	15	8,7 ± 2,15	10	5,8 ± 1,78
4	10000	148	21	14,2 ± 2,87	15	10,1 ± 2,48
5	20000	138	25	18,1 ± 3,28	18	13,0 ± 2,75
6	30000	124	26	21,0 ± 3,66	20	16,1 ± 3,30
	Total	772	98	12,7 ± 1,20	70	9,1 ±1,03

In the AzNIXI-104 cotton variety, the number of variables in 500 rad influence recorded in 22 out of 195 families in M_2 and in 25 out of 155 families in 20000 rad decreased in M_3. In M_3, mutations were obtained in 14 families in 500 rad, 17 families in 5000 rad, 21 families in 20, and 22 families in 30000 rad.

In general, hereditary variability was recorded in 116 (12.9 ± 1.17%) of 899 families assessed in M_2 due to pre-sowing influence to gamma radiation in AzNIXI-104 cotton variety, while in 92 families (10.2 ± 1.01) in M_3 % true mutation variability has been known.

A similar variation of variability was observed in AzNIXI-195 variety. Seeds of this variety were affected by gamma radiation and there were obtained mutation changes that was as below: at a dose of 500 rad – in 11 families from 191 families in M_2 (5.7 ± 1.68%) and in 7 families in M_3 (3.7 ± 1.36%); at a dose of 5000 rad – in 15 families from 172 families in M_2 (8.7 ± 2.15%) and in 10 families in M_3 (5.8 ± 1.78%); at a dose of 10000 rad – in 21 families from 148 families in M_2 (14.2 ± 2,87%), 87%) and in 15 families in M_3 (10.1 ± 2.48%); at a dose of 20000 rad – in 25 families from 138 families in M_2 (18.1 ± 3.28), and 18 families in M_3 (13.0 ± 2.75%); at a dose of 30000 rad in 26 families from 124 families in M_2 (21.0 ± 3.66%) and in 20 families in M_3 (16.1 ± 3.30%). In general, it has been confirmed mutation variability in the variety AzNIXI-195 under the influence of pre-sowing gamma radiation in 98 families from 772 studied families in M_2 (12.7 ± 1.20%) and in 70 families (9.1 ± 1.03%) in M_3. No variability was observed in the plants in the control variants of both cotton varieties.

The table shows that as the gamma ray dose increases, the variability rate increases in both generations. Mutation variability in AzNIXI-104 variety in M_2 is 7.1 ± 1.61% in the variant with 500 rad effect, 11.2 ± 2.26% in the variant with 5000 rad effect, 13.1 ± 2.55% in the variant with 10000 rad effect, 16.1 ± 2.95% in the variant with 20000 rad effect, and 23.3 ± 3.86% in the variant with 3000 rad effect. Thus, the percentage of mutant plants in families has increased due to the increase in gamma radiation dose.

There was similar mutation variability in the doses of gamma rays in the AzNIXI-195 variety. Thus, 5.7 ± 1.68% in the 500 rad effective variant, 8.7 ± 2.15% in the 5000 rad effective variant, 14.2 ± 2.87% in the 10000 rad effective variant, 18.1 ± 20000 rad in the effective variant 3.28%, and in the effective variant of 30000 rad it was 21.0 ± 3.66%. Due to the pre-sowing effect of gamma rays on the seeds, the number of mutant families was the same in all variants of the two varieties.

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