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THE GENETIC NATURE OF MUTATIONAL CHANGES ARISING IN THE FORM-FORMATION PROCESS OF WHEAT

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Abstract

Increasing the yield of wheat by improving its genotype is one of the most pressing problems of agriculture and the economy. Currently, the usage of traditional breeding methods and the results of genetic investigations, such as conduction of saturating crosses, remote hybridization and experimental mutagenesis, increases the efficiency of producing genetically modified and enriched forms of wheat. In field and under controlled laboratory conditions, the effect of a surfactant on the heritable characteristics of 10 varieties of spring soft wheat was studied. After processing of wheat seeds with an aqueous surfactant solution (0.1%), we could observe the inherited changes, which are manifested in the appearance in M_1, M_2, F_2 and BC_1 of tall, potent plants with productive bushiness and various morphological characteristics that differ from the original varieties. The effect of surfactants is manifested on the morphological features of plants: bushiness, crankiness of the stem, anthocyanin stain color. During the process of meiosis, the spindle of the division of the metaphase plate, the coalescence of chromosomes in MI, and the presence of empty (sterile) cells in AI and AII meiosis were observed. The signs of altered forms are stably transmitted in the M_2 generation.

Keywords: selection, chemical mutagenesis, variety.

БИДАЙДЫҢ ФОРМАЛЫҚ ПРОЦЕСІНДЕ БОЛАТЫН МУТАЦИОНАЛДЫҚ ӨЗГЕРІСТЕРДІҢ ГЕНЕТИКАЛЫҚ СИПАТЫ

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Аңдатпа

Бидайдың генотипін жақсарту арқылы оның өнімділігін арттыру ауыл шаруашылығы мен экономиканың өзекті мәселелерінің бірі болып табылады. Қазіргі уақытта дәстүрлі селекция әдістерін және қанықтыру айқастарын жүргізу, қашықтықтан будандастыру және тәжірибелік мутагенез сияқты генетикалық зерттеулердің нәтижелерін қолдану бидайдың генетикалық түрлендірілген және байытылған түрлерін өндірудің тиімділігін арттырады. Далалық және бақыланатын зертханалық жағдайларда жаздық жұмсақ бидайдың 10 сортының тұқым қуалау қасиеттеріне БАЗ әсері зерттелді. Бидай тұқымын сулы беттік-белсенді зат ерітіндісімен (0,1%) өңдегеннен кейін тұқым қуалайтын өзгерістерді байқауға болады, олар М1, М2, F2 және ВС1-де өнімді бұталы және әртүрлі морфологиялық сипаттамаларымен ерекшеленетін биік, күшті өсімдіктердің пайда болуымен көрінеді. түпнұсқа сорттардан. Беттік-активті заттардың әсері өсімдіктердің морфологиялық ерекшеліктеріне: бұталылыққа, сабақтың иілгіштігіне, антоциандық дақтардың түсі бойынша көрінеді. Мейоз процесі кезінде метафазалық пластинаның бөліну шпинделы, МИ-де хромосомалардың бірігуі, АИ және АII мейозында бос (стерильді) жасушалардың болуы байқалды. Өзгертілген формалардың белгілері М2 буынында тұрақты түрде беріледі.

Түйін сөздер: селекция, химиялық мутагенез, сорт.

ГЕНЕТИЧЕСКАЯ ПРИРОДА МУТАЦИОННЫХ ИЗМЕНЕНИЙ, ВОЗНИКАЮЩИХ В ФОРМООБРАЗОВАТЕЛЬНОМ ПРОЦЕССЕ ПШЕНИЦЫ

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Аннотация

Повышение урожайности пшеницы путем улучшения ее генотипа является одной из актуальнейших проблем сельского хозяйства и народного хозяйства. В настоящее время использование традиционных методов селекции и результатов генетических исследований, таких как проведение насыщающих скрещиваний, дистанционная гибридизация и экспериментальный мутагенез, повышает эффективность получения генетически модифицированных и обогащенных форм пшеницы. В полевых и контролируемых лабораторных условиях изучено влияние ПАВ на наследуемые признаки 10 сортов яровой мягкой пшеницы. После обработки семян пшеницы водным раствором ПАВ (0,1%) наблюдались наследственные изменения, проявляющиеся в появлении в M1, M2, F2 и BC1 высокорослых, мощных растений с продуктивной кустистостью и различными морфологическими признаками, отличающимися из исходных сортов. Действие ПАВ проявляется на морфологических признаках растений: кустистость, курчавость стебля, антоциановая окраска. В процессе мейоза наблюдали веретено деления метафазной пластинки, слияние хромосом в ИМ, наличие пустых (стерильных) клеток в мейозе АИ и АII. Признаки измененных форм стабильно передаются в поколении M2.

Ключевые слова: селекция, химический мутагенез, сорт.

Introduction

Mutational selection involves the development of new varieties by creating and using genetic variability through chemical and physical mutagenesis (Bogdanova E.D. et. al. 2003) Completely new forms such as dwarf mutants of wheat and barley, superfast mutants in barley, plants resistant to fungal diseases, highly productive mutants serving as precursors of new high-yielding varieties, are obtained as a result of chemical mutagenesis (Grodnitsky D.L. et. al. 2001). However, obtaining mutants and studying them is only the first stage of breeding work. In the selection of mutations, hybridization can be used. It is more important to use the mutants in hybridization to obtain positive transgressions (Larchenko E.A., Morgun V.V. et. al. 2000).

The preparation of mutants and their use for hybridization requires studying the genetic nature of the changes which occur in living cells, which is crucial for the selection of effective mutagens with a specific effect, and for expanding and deepening understanding of the nature of wheat evolution. To increase the efficiency of mutational plant breeding and the yield of appropriate mutations, it is essential to study the conditions and methods of mutagenic process that allow expanding the spectra of hereditary variability. Induced hereditary changes (mutations) caused by physical and chemical mutagens are random and cannot be controlled. For example, a high mutagenic activity of ethylenimine, diethyl sulfate and dimethyl sulfate is shown on a number of specimens of peas and beans. It was shown that with increasing the mutagen concentration the incidence of mutations increases too, but most mutants did not represent a breeding value (Burasheva G.Sh., Kudinov P.I., Karaim T.V., Kharkwal M.C. 2012).

Of great importance is the problem of studying genetic effects and, in particular, the specificity of changes in mutations caused by the modifying effects of environmental conditions (certain fertilizer doses (Chunetova Zh. et. al. 2010], the effects of nicotinic acid of natural origin) that caused certain changes - the emergence of powerful tall plants, the so-called large genotrophs (Rappoport I.A. 1993). The difference in size persisted in subsequent generations. Such changes, according to Waddington, are called "epigenetic mutations." "Epi" in Greek means "outside", "near", i.e. differences that occur somewhere near the genes, near them, but not in themselves genes (Pathirana R., Roychowdhury R., Tah J. 2013).

In recent years, the attention of researchers has attracted the use of surfactants in various fields of science (medicine, agriculture, etc.).

It is shown that surfactants have not only bactericidal activity, but also the ability to enhance the action of various antibiotics. In the culture of fibroblasts, surfactants disrupt ion homeostasis; stimulate the synthesis of DNA and proliferation of the cell monolaye (Gomes-Arroyo S.R. et al 2013)

P.I. Kudinov and T.V. Karaim conducted studies that showed the inhibitory effect of surfactants (methacide) on the bacteria of th e potato bacillus group when processing wheat grain; they also found the optimal dosage of metacid for grain processing.

We used a surfactant, which was obtained on the basis of a plant of camel thorn. Employees of the Department of Organic Chemistry of the Chemical Faculty of KazNU named after al-Farabi determined the polyphenolic composition of this plant and revealed biologically active substances showing physiological activity. The drug, called alchidine - polymer proanthocyanidin is non-toxic. The conducted studies showed a high degree of inhibition of cell division during the action of alchidine on malignant neoplasms. Based on surfactant (alchidine), an antitumor drug was obtained. This drug was also used to preserve eggs in the Research Institute of Fishery (Astrakhan), while the content of vitamin E was increased by 2 times.

Because of the treatment of wheat seeds with a surfactant (alchidine), we obtained powerful plants with high productive bushiness, thick straw, as well as plants with long ears and elongated scales having large vitreous grains. The mechanisms of the damaging development or changing the quantitative and qualitative characteristics of plants under the influence of surfactants have been little studied and require further investigation.

Materials and Methods

The material of the study was the plants M1, M2, obtained from the treatment with a surfactant of 10 regionalized varieties of spring soft wheat (Shagala, Tolkyn, Dauyl, Kazakhstan 17, Kazakhstan 4, Kazakhstan 3, Zhenis, Lutescens 32, Aray, Kazakhstan 10), as well as offspring of hybrids F1, BC1 from recurrent crossing of altered plants with initial varieties.

The treatment was carried out by soaking the seeds with a 0.1% surfactant solution for 5 hours, at a temperature of 25-27°C. Control was dry wheat seeds. Surface treated M1 seeds were seeded in duplicate for 100-200 pieces. Selection of the modified plants was carried out in M2. The proportion of the changed plants was taken into account by different characters from the total number of planted plants. Plants with altered traits in M2 were again sown to produce M3 progeny.

Genetic analysis of the modified plants M2 was carried out by crossing them with the original varieties. The analysis of the progeny of F1 hybrids from reciprocal crossing, as well as F2 hybrids and BC1. In experiments were used the following research methods: cytogenetic, hybridological, statistical and morphological. Cytological studies carried out in temporary squash preparations, using microscope LOMO Mikmed-1. Genetic analysis of hybrids F1 and F2 was carried out according to qualitative and quantitative traits of wheat. Statistical data processing was to find the arithmetic mean and its error for the analyzed quantitative traits and definition of the reliability of differences between the arithmetic with the help of student's criterion (t), genetic – finding accurate values of $\chi 2$ (Armor V.A. 1985). Accounting of chromosomal abnormalities in MI, AI and ALL of meiosis was carried out on time acetocarmine preparations under the microscope MBI-3. The representativeness of the research results ensured a sufficient sample size – 60 to 100 plants.

Mathematical processing of data was performed by finding the arithmetic mean and its error for the analyzed quantitative traits and to evaluate the accuracy of the difference.

Results and Discussion

Morphological changes of plants under the action of surfactants.

The study of the effect of surfactants on regionalized varieties of spring soft wheat (Shagala, Tolkyn, Dauyl, Kazakhstan 3, Kazakhstan 4, Kazakhstan 17, Zhenis, Lutescens 32) showed that the effect of surfactants leads to various morphological changes in plants, expressed in stimulating germination, accelerating the growth of primary cornea and the subsequent increase in the productivity of plants. The modified plants were distinguished by increased bushiness, in comparison with the control (by 3-4 stems), higher and thicker straw, thickening and elongation of stem nodes, lengthening of the joints of the rod, anthocyanin color of the straw and coleoptiles, and a larger grain. Morphological changes in the spike were expressed in the appearance of plants with a supra, speltoid, multiflorous, compactoid, branchy, friable and long spike. At the same time, plants with fragile ears and thin straw were found. In some varieties of the experimental variant, a wide range of variability in plant height was noted. All these changes in the quantitative and qualitative traits of wheat may be related to epigenetic changes.

In the experimental variant of Kazakhstani specimen 3, a large variation of the spike types was observed, and it proved to be the most susceptible to the action of surfactants.

Among a variety of altered forms, plants with elongated ears, with long scales and glassy elongated grains, have been selected that are resistant to different types of rust, which is important for breeding for resistance.

For example, varieties Dauyl, Lutescens 32, Zhenis and Shagala were distinguished by their high bushiness, elongated spike, extended form of internodes.

Table 1: Shows the data on the elements of productivity of varieties under the influence of surfactants

Variants Average Height (cm) Productive bushiness	**Variants Average**				
	Height (cm) Productive bushiness	**Height (cm) Productive bushiness**	**Height (cm) Productive bushiness**	**Height (cm) Productive bushiness**	**Height (cm) Productive bushiness**
Aray - K	103,7 ± 0,7 99,9**± 1,6	6,8 ± 0,6 10,6*** ± 0,9	11,0 ± 0,2 9,8***± 0,4	43,0 ± 0,8 48,0 ± 0,2	1,3 ± 0,2 1,5 ± 0,1
An experience	117,0 ± 1,1 110,0**± 1,9	6,8 ± 0,7 10,5***± 0,1	11,1 ± 0,7 7,8** ± 1,3	41,7 ± 0,5 49,7* ± 1,0	1,7 ± 0,2 1,4 ± 0,3
Daouil-K	103,5 ± 0,5 101,2 ± 1,8	7,3 ± 0,4 10,7* ± 1,3	10,8 ± 0,1 10,7 ± 0,8	45,5 ± 1,0 39,6***± 0,4	1,6 ± 0,5 1,0 ± 0,4
An experience	99,3 ± 0,8 102,1* ± 1,1	4,8 ± 0,6 12,0*** ± 0,3	12,3 ± 0,8 10,5 ± 1,1	33,0 ± 0,8 38,3*** ± 0,2	1,9 ± 0,6 1,2 ± 0,3
Chagall - K	107,2 ± 0,3 106,6 ± 0,4	10,5 ± 0,9 10,6 ± 1,5	11,5 ± 1,3 16,8*** ± 0,4	38,0 ± 0,1 36,0 ± 0,9	1,3 ± 0,2 1,2 ± 0,3
An experience	79,0±0,2 79,4±1,1	9,3 ± 1,0 10,5 ± 1,6	6,3 ± 1,6 10,4** ± 1,9	34,5 ± 0,7 37,6***± 0,3	1,1± 0,1 2,8***± 0,3

As can be seen from Table 1, surfactant significantly reduces the height of plants of the following varieties: Arai by 3.8 cm, Dauyl by 7.0 cm, Shagala by 2.3 cm, Zhenis by 2.8 cm.

With a significant decrease in the average height of plants in these varieties significantly increases their productive bushiness 10.6 ± 0.9; 10.5 ± 0.1; 10.7 ± 0.3; 12,0 ± 0,3 in comparison with the control 6,8 ± 0,7; 7.3 ± 0.4 and 4.8 ± 0.6, respectively. In Kazakhstan 3 and Lutescens varieties 32 differences in plant height between control and trial variants were not observed.

In the grade of Kazakhstan 10, the stalk was 4.8 cm longer than the control.

Mass of grain from the main ear. With the action of surfactants in almost all studied varieties, the amount and mass of grain from the main spike remains at the control level. The exception is grade Kazakhstan 3, where there was a significant increase in both the number of grains (by 3.1 grains) and the weight of grain from the main ear (1.65 g) compared to the control. In this case, there was a specific reaction of the genotype – Kazakhstan 3 to the effect of surfactants. At the same time, there was a tendency to increase all the studied features of Kazakhstani variety 3, except for plant height, which remains at the control level.

To study the inheritance of morphological characters of Kazakhstani variety 3, a reciprocal crossing was performed between the altered plants M1 and the initial variety. The initial grade Kazakhstan 3 does not have a pubescent ear, anthocyanin stalk color and an elongated form of the cauline node, and in some plants M1, these features are evident.

Table 2: Reciprocal crossing of modified plants of Kazakhstan variety 3 with initial variety

Symptoms	**Kaz 3**	**M_1**	**К 3 x M_1**	**M_1 x Kaz. 3**
Spout of the ear	not pubescent	pubescent	pubescent	pubescent
Staining of stalks	not painted	painted	painted	painted
Shape of cauline nodes	normal	elongate	elongate	elongate
Height of plants	79,0±1,2	86,0***±0,8	86,4±0,2	88,3±0,3
The length of the main ear (cm)	9,3 ± 0,6	12,3**±0,7	13,3±0,3	13,9±0,3
Number of grains with Ch. ear	34,5 ± 0,7	39,0 ± 0,6	41,5 ± 1,1	43,7 ± 1,1
Grain weight from gl.	1,0±0,1	2,7±0,3	3,0± 0,8	3,7 ± 0,5

As can be seen from Table 2, the altered morphological features manifest themselves irrespective of the direction of crossing. This indicates a possible inheritance of these features in the succeeding generations M2 and Mn.

The results of the studies showed that the reaction to the action of the surfactant depends on the genotype of wheat. The variability found in M1 for a number of quantitative and qualitative characteristics persisted in the subsequent generation of M2. This was confirmed by the results of the analysis of the crossing and analysis of the M2 progeny. The presence of altered forms with positive signs: short-stemmed plants with powerful, multiflorous, pubescent ears; plants differing in length and shape of the main ear; by the color, shape and size of the grain can be considered as confirmation of the presence of a gene-regulator, which underwent epigenetic changes and, in turn, influences the expression of the registered genes. However, for a simultaneous change in the characteristics of mutants that are different among themselves, the same gene regulator can not respond. The change that we observe is most likely a consequence of the change in some general processes in the cell that arise in response to the effect of the surfactant.

The effect of surfactant s on cell division. Chromosomal aberrations and cell division disorders are one of the main tests for mutagenicity in certain exposures. The most revealing in this respect is the meiotic division of cells, especially in objects such as wheat, which have a large number of hard-to-identify chromosomes.

The main phases on which meiosis is disturbed are metaphase, anaphase of the first division and tetrad. Metaphase I observed such types of disturbances as univalent, polyvalent, open bivalents, chromosome adherence - "pycnosis" and displacement of the spindle of division of the metaphase plate (Table 3).

Table 3: Metaphase I in Controlled and Modified M1 Plants under the Influence of Surfactants Note: К – control variant; experience – experienced

Variant	**Number of cells studied**		**Percentage of cells**					
	all	**cells with impaired**	**violations**	**univalent**	**open bivalents**	**pycnosis**	**dislocation of metaphase plates**	**polyvalent**
Kaz 3 – К	159	32	20	-	12	-	-	-
experiment	164	78	47	4	12	30		
Kaz 10 – К	153	16	10	9	-	-	1	-
experiment	185	113	61	12	21	8	18	
Tolkyn – К	166	20	12	2	4	2	4	-
experiment	156	129	82	15	14	25	26	
Aray – К	155	15	8	-	8	-	-	-
experiment	151	46	30	15	5	1	7	
Kaz 17 – К	175	18	13	6		3		6
experiment	225	167	74	16	13	22	22	
Dauyl – К	162	12	14		8	-	-	-
experiment	195	49	25	4	12	1,5	4	
Kaz 4 – К	156	15	9	-	3	-	6	-
experiment	151	70	46	8	11	14	11	
Zhenis – К	155	19	12	2	9	-	-	
experiment	154	80	51	10	22	18		1
Lut. 32 – К	168	15	8	8				
experiment	152	68	44	16	5	9	11	1
Shagala – К	172	16	9	11				
experiment	178	161	90	24	22	28	15	

Note: К – control variant; experience – experienced

The changes observed in MI were accompanied by a violation of cell division in AI. In this phase, fragments of chromosomes, bridges, asynchronous fission, empty cells were observed. At the level of tetrads - cells with microkernels (Table 4). All these changes are a manifestation of violations that occurred at earlier stages, mainly in interphase and early prophase.

Table 4: Anaphase I in Controlled and Modified M1 Plants under the Influence of Surfactants

Variants	**Number of cells studied**		**Percentage of cells**					
	all	**cells with impaired**	**violations**	**univalent**	**open bivalents**	**pycnosis**	**dislocation of metaphase plates**	**polyv alent**
Kaz 3 – К	156	17	10,8	3,2	1,2	6,4		

experiment	154	66	42,8	17,8	12,9			13,6
Kaz 10 – К	167	11	6,5	3,0		3,5		
experiment	158	30	18,9		3,1	15,8		
Tolkyn – К	165	6	3,6	0,6		3,0		
experiment	151	52	34,4	9,9	1,3	19,8	3,3	
Aray – К	159	15	9,4			9,4		
experiment	158	71	44,9	5,0	3,1	6,3	14,5	15,8
Kaz 17 – К	167	10	5,9		5,9			
experiment	156	84	53,8	2,5	12,8	19,2	1,2	19,2
Dauyl – К	187	14	8,8	3,2	4,8	4,4		
experiment	154	93	60,0	6,4	22,7	20,7		
Kaz 4 – К	171	5	2,2	1,5	4,0	3,6		
experiment	158	68	43,0	6,3	5,0	8,0	3,0	20,0
Zhenis – К	153	13	8,4	5,2	1,3	2,0		
experiment	156	75	48,0	16,0	6,4	3,0		20,0
Lut. 32 – К	157	4	2,54	1,9		0,6		
experiment	152	64	42,0	17,0	1,3	2,6	1,9	11,8
Shagala – К	161	10	6,0	0,6	0,6	4,0		
experiment	156	65	40,0	8,0	3,0	5,0	7,0	17,0

So the maximum percentage of cells with univalents was found in the experimental variants of Kaz 10 (12%), Tolkyn and Aray (15%), Kaz 17 (16%) and Shagala (24%).

In the control grade of Kazakhstani specimens, 10 cells with univalents made up only 3%, Tolkyn 2%, Kazakhstan 17 and Shagala - 6%. In the remaining studied varieties, the disturbance ranged from 4% to 11%, and in control variants from 1% to 6%.

A high percentage of cells with open bivalents was found in the varieties Zhenis - 34% and Shagala - 40%, and in control 9% and 5%, respectively. Pictures, such as open bivalents and univalents can be associated with chromosomal rearrangements that violate the complete homology of chromosomes.

One of the frequent violations in the treatment of SAW seeds was the adhesion of chromosomes (pycnosis). A high percentage of such cells was found in the experimental variants: varieties Kazakhstani 3 (30%), Tolkyn (25%), Kaz 17 (22%). Zhenis (18%) and Shagala (28%). In control variants, cell picnosis was not detected. The adhesion of chromosomes occurs if the replication of chromosomes is disrupted in the interphase of pre-meiotic division.

Cells with displacement of spindle of division of metaphase plate are found in all varieties, except for cultivars Kazakhstani 3, Zhenis and Lutescens 32, in others the percentage of such cells was from 4% to 26%, and in control variants, such violations were absent.

Cells with a polyvalent configuration of chromosomes were found only in varieties Kazakhstani 17 (6%) and Zhenis (0.6%). In the control variants, these disorders were not detected. In wheat, as a rule, polyvalents are a consequence of conjugation of homologous chromosomes and this occurs with an extension of the conjugation time in the stage of diplotenes. As is known, the chromosome 5B corresponds to this process in wheat.

A comparative analysis of cell damage in different wheat varieties in Metaphase I and Anaphase I meiosis in fractions is given in Table 5.

Table 5: Proportion of cells with disorders in Metaphase I and Anaphase I under the action of surfactant

Variants	cells with disorders of Metaphase I	cells with disorders of Anaphase I
Kaz. 3 control	0,8	0,10
experiment	0,47***	0,42***
Kaz. 10 control	0,10	0,06
experiment	0,61***	0,18
Tolkyn control	0,12	0,03
experiment	0,82***	0,34***
Aray control	0,28	0,09
experiment	0,30	0,44***
Kaz. 17 control	0,13	0,05
experiment	0,74***	0,53***
Dauyl control	0,6	0,5
experiment	0,25***	0,60***
Kaz. 4 control	0,09	0,2
experiment	0,46***	0,43***
Zhenis control	0,12	0,08
experiment	0,51***	0,48***
Lut. 32 control	0,08	0,02
experiment	0,44***	0,42***
Shagala control	0,09	0,06
experiment	0,90***	0,40***

As can be seen from Table 5, the proportion of cells with disorders in MI meiosis in Kazakhstan 3 was 0.47, and in control 0.8; Kaz. 10 - 0.61 and 0.10; Tolkyn - 0,82 and 0,12; Aray - 0.30 and 0.28; Kaz. 17 - 0.74 and 0.13; Dauyl - 0.6 and 0.5; Kaz. 4 - 0.46 and 0.09; Zhenis - 0,51 and 0,12; Lut. 32 - 0.44 and 0.08; Shagala - 0.90 and 0.38.

In the experimental variant in Meiosis AI in the Kazakhstani strain 3, the proportion of cells with impairments was 0.42, and in control 0.10; Kaz.10 - 0.18 and 0.06; Tolkyn - 0.34 and 0.03; Aray - 0.44 and 0.09; Kazakhstan 17 - 0.53 and 0.05; Dauyl - 0.60 - 0.28; Kazakhstani 4 -0.43 and 0.2; Zhenis - 0,48 and 0,08; Lutescens 32 - 0.42 and 0.02; Shagala - 0.40 and 0.06. As can be seen from Table 5, the proportion of violations in A1 in the pilot variants is much higher than in the control.

The carried out researches have shown reliable influence of surfactants on quantitative and qualitative attributes of wheat. The surfactant causes an increase or decrease in some of the productivity elements of the altered plants as compared to the control variety. The changed signs were inherited in M2. This is confirmed by the phenotypic manifestation of these features in F1 (BC1) hybrids, in reciprocal crosses. The abnormalities detected in MI, AI and tetrads indicate the effect of surfactants on the meiosis process. As is known, violations occurring before meiotic division are more often transmitted to the next generation.

Thus, the obtained results of the study can have applied value, since under the influence of surfactants, along with suppression of plant development, altered forms with enhanced viability were revealed. The study also found that the reaction of wheat plants to the effect of surfactants depends on the genotype of the studied wheat varieties. The changes observed by us could be a consequence of some general processes in the cell that arise in response to the effect of surfactants. This requires studying the effect of surfactants at the molecular-genetic level. It is planned to conduct chromosomal localization of genes that control the elongation of the ear of wheat, the extension of wheat grain, productive bushiness, anthocyanin color of grain and anthers in the modified plants M3 in Kazakhstani 3. The line obtained, with the above-inherited traits of this variety, can serve as a source of signs of wheat productivity.

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