ECOGENETIC VARIABILITY OF WINTER WHEAT UNDER THE GAMMA RAY'S ACTION

Oleksandr IZHBOLDIN
Candidate of Agricultural Sciences, Associate Professor of the Department of Plant Production, Dnipro State Agrarian and Economic University

Mykola NAZARENKO
Doctor of Agricultural Sciences, Professor of the Department of Plant Breeding and Seedfarming, Dnipro State Agrarian and Economic University
Olena IZHBOLDINA
Candidate of Agricultural Sciences, Associate Professor of the Department of Livestock Production Technology, Dnipro State Agrarian and Economic University

Chapter is devoted to the possibilities of using ecogenetic variability under the influence of gamma-rays to increase the biodiversity of winter wheat agrocenoses on the basis of local resources to obtain stable high-grain-productive and high-quality systems. Regularities and ways of using-gamma rays as an ecogenetic factor are established. The aim of the work was to investigate the ecological and genetic bases of creating high-productive and quality stable agrocenoses of winter wheat by increasing biodiversity through gamma-rays induction based on regional (local) varieties material. According to the results of scientific research at different levels of the organization of agrocenoses of cereals for the first time showed the relationship between variability at the cellular level and the consequences for the plant organism as a whole in terms of variability in characteristics; determined traits of depression for varieties of regional (local) breeding for the possibility of their use as source forms under the action of gamma rays; establishing the prospects for the use of local resources to increase artificial biodiversity in terms of total variability and stability in the mutation process.

Key words: *bread winter wheat, gamma-rays, formation action, yield, grain quality.*

Interdisciplinary research on the relations of agroecosystems through the knowledge of genetically determined processes, in particular the induction of biodiversity and its preservation at an appropriate level to increase the potential capacity of agrocenoses of cultivated plants, allows to move to the regulation of productivity processes and the formation of quality at a fundamentally new level of regulation of genetic aspects of the interaction of organisms, as well as changes organism under the influence of ecogenetic factors: investigating the interaction of genetic processes and ecological relations (Abe & Matsuyama, 2002).

The problem of realizing the genetic potential of modern agricultural crops has led to the need to take into account the features of the plant's existence in the interaction between the genotype and environmental factors, taking into account the context of the interaction, its complexity, and the features of the genetically determined adaptive reaction. Only in this way is it now possible to effectively increase the overall productivity, technological qualities of products obtained from agrocenoses, without significantly harming its relative stability, and sometimes even increasing it (Ahloowalia, 2001).

Under this approach, the mutagen is considered simultaneously as a genetic and environmental factor, which leads to the expansion of the possibilities of using the norm of the organism's reaction, its adaptive abilities, the level of variability and regulation of the adaptive response at the genome level.

The application of ecological genetics approaches allows to identify genetically active factors of the environment, to determine the mechanisms of increasing mutational variability and the possibilities of regulation of these mechanisms, to investigate specific features of the formation of an adaptive response at different levels of the organization of the agrocenosis of agricultural crops (Ahloowalia & Maluszynski, 2005).

An applied aspect of the study of ecogenetic features is the problem of regions with increased anthropogenic load, the study of the features of spontaneous variability, the improvement of methods for the detection and use of hereditary changes, the establishment of mechanisms of the residual and excess action of genetically active factors of various nature, the identification of the optimal amount of an ecogenetic factor for the creation of a stable, highly productive plant organism with the given parameters of product quality, the possibility of using natural mechanisms of regulation through biodiversity to stabilize agrocenoses and reduce the role of anthropogenic subsidies (Aiyi et al., 2006).

Searching for opportunities to adapt classical methods of using mutagenic action in the realities of today's restrictions, eliminating the negative features of the corresponding activity in the form of depressive consequences or fully taking them into account in programs for the genetic improvement of winter wheat, regulating interaction within the framework of using a specific anthropic system and the need for maximum involvement of local resources for increasing the stability of the obtained results - all these are the main problem areas that modern ecological genetics must solve. This approach to the intensification of the biodiversity of cereal crops through the use of the mutation process is relevant for the departments of agroecology, genetics and breeding and allows at different levels of the organization of a living organism to manage the variability of agrocenoses and its individual components (Asif, 2020).

The phenomenon of mutation, as a rule, is associated with changes in the structure of DNA. At the current level of understanding, the main cause of spontaneous mutagenesis is repair errors and the mobility of the genome of a cultivated plant. Other reasons are rare, unlikely (Amram et al., 2015).

The scientific justification of the mutation process as a classic for the regular improvement of plants can be found in the fundamental work "Mutationszichtung", which was published in 1944 and concerned the improvement of the productivity of varieties and hybrids through the use of artificial mutagenic factors, primarily of a physical nature, along with more traditional methods at that time hybridization and the need to implement special breeding studies based on radiobiological projects (Freisleben & Lein, 1944).

Early 1900s Hugo de Vries proposed the use of radiation to introduce mutations in agricultural plants and provided a theoretical basis for this future direction (Gasperini D. et al., 2012).

The obtained mutant material can be classified according to the international system into three groups: hybrid material that received a mutagenic effect in one form or another during hybridization (that is, the mutant effect enhanced the recombinant process and played a synergistic role) - mutant-recombinant varieties; genotypes obtained from the crossing of mutant forms or if only one of the components has a mutant origin - the so-called hybrid-mutant populations, which played a special role during the "green revolution"; directly to the population of linear material that received a mutagenic effect - it is not essential what was its subject and what is the nature of the mutagenic factor in terms of the classification itself (Forster, 2001).

The ecological-genetic approach in experimental mutagenesis begins with complex studies: first of all, the registration of radiobiological effects of the action of the mutagenic factor, then the identification of a specific DNA-disruption at the molecular level, the determination of the connection of phenological variability with specific changes in DNA, the search for variations of the resulting change and the identification of the limits of variability in the manifestation of a changed sign - a group of signs. The modern development of ecological genetics as a discipline is mainly connected with these studies (Fellahi et al., 2018).

The peak in the activity of classical mutation selection falls on the period of the 60s - the beginning of the 90s of the 20th century. At the same time, the maximum number of mutant varieties actively used in agriculture was created. In connection with the more active use of genetic transformation and methods of direct manipulation of the genome, the mutation process took a back seat, and the intensity of relevant research significantly decreased. The approach with the selection and assessment of the obtained material only at the phenotype level or with the use of only biochemical methods of analysis of the obtained population has become considered somewhat outdated and not always scientifically justified (Branch, 2002).

The beginning of our century was marked by the synthesis of the use of the mutation process in plant improvement through the use of reverse genetics methods, which requires large populations with high induced genetic variability to obtain the necessary volumes for data analysis with a large number of molecular variants of changes in each DNA fragment and DNA associations. Understanding the genetic basis of the occurrence of mutations (through transformation and hereditary changes in DNA) has transformed the induction of biodiversity from a method of randomly obtaining possible beneficial changes to a precise technique (Cain, 1992).

The key feature for the success of the "green revolution", which determined the cardinal success of mutational selection, was the shortness of the stem, which had a mutational nature (Norin 10, Krasnodar dwarf). Thanks to this feature, a fundamentally new variety type was formed in terms of shoot architecture, which ensured a decrease in vegetative mass in favor of grain (Feldman, 2005).

Such significant changes played a key role in creating the optimal structure of the wheat shoot in terms of the ratio of vegetative and generative parts and thus creating agrocenoses with a yield 40-60% higher than the previous one. This type of change is quite likely, and it is the third most common type of change among visual changes that are typically identified in mutational selection programs. Thus, it is quite easy to create new short-stemmed forms for new crops to increase grain production. Then, changes in leaf color (chlorophyll mutations) and male sterility, which also occur quite often and belong to highly probable changes, found their application, and their niche became hybrid seeding of a wide range of grain crops (Qelik et al., 2018).

As for parameters that have low potential variability, direct manipulation at the molecular genetic level or insertional mutagenesis at small genome sizes remains more effective here (Diaza et al., 2004).

New traits produced by gamma rays have been used in genetic control research since experiments in the mid-20th century, but only with the provision of the necessary tools at the molecular level has this approach become effective enough for practical application. (Datcu et al., 2020).

The beginning of the 21st century made it possible to obtain tools at the level of the genome of a cultivated plant, which makes it possible to significantly intensify ecological and genetic research. The possibility of revealing ecological regularities at the molecular level ensured the revival of the use of the mutation process (Das & Uddin, 2000).

The possibility of identifying a specific locus of quantitative traits and the corresponding biochemical product or group of products and the interaction of these associations allows for accurate genotyping of any material for natural or artificial biodiversity of cereal crops (ecophysiological approach to the study of biodiversity of cereal crops according to the European classification) (Chopra, 2005).

DNA mapping and establishment of genetic control directly at the molecular genetic level is a fundamental possibility that allows to predict the phenotypic variability of the plant population on the basis of changes at the elementary level. Currently, the main problem that prevents the reliable use of so-called genomic selection is the insufficient amount of data on all possible germplasm variations even within individual genetic bases and the insufficient number of phenological observations to establish the characteristics of the manifestation of traits at the phenome level (Collins et al., 2008).

For ecological genetics, when using an artificial mutation process, a polygenic complex of valuable traits that has stable characteristics and phenotypic manifestation is important, i.e.: grain productivity, technological qualities of grain, resistance to adverse biotic and abiotic factors, the ability to effectively use anthropogenic energy and resource subsidies. These ecological and genetic experiments are of particular importance 27 in the current conditions of global climate change. Establishing connections between the genetic control of a trait and its phenotypic manifestation is a major challenge (Canet et al., 2007).

Physical agents that cause damage to the DNA molecules of a living organism are called physical mutagens or mutagenic radiation. Over the past 80 years, physical mutagens, mainly ionizing radiation, have been widely used to induce hereditary changes. Thus, more than 70% of mutant varieties were created using physical mutagenesis. Based on the ability to produce ions, radiation is divided into ionizing and non-ionizing. Factors determining the level of variability are the type of mutagen, the dose and duration of action of the mutagen, and the processing method (including material selection, preparation, and cultivation after processing). Despite the fact that the sensitivity to gamma rays of many plant organisms has already been evaluated and appropriate protocols for the treatment of various plant objects have been created, there is always a fairly high dependence on the genotype, which sometimes requires a more careful approach to the evaluation of the chosen method (Das et al., 1999).

In general, ionizing radiation has a common property - to cause the release of energy, called ionization, during its passage through matter. But they differ in their ionization ability and have unique properties. In plant mutagenesis, energy and penetrability are two key technical parameters affecting mutagen efficacy. Other such factors include, for example, source availability and availability, suitability for processing a particular type of plant tissue, safety for processing and post-processing management, cost of processing (Das et al., 2003).

Since the 1960s, gamma rays have been the most widely used ionizing radiation in plant breeding; During the last two decades, ionizing radiation has also been shown to be an effective and unique mutagen. Other types of radiation, such as X-rays, α- and β-particles, neutrons, and ultraviolet light, have also shown utility in inducing mutation in plants, either for specific types of material or for specific purposes (e.g., fast neutrons cause deletion mutations), but still however, their efficiency is much lower (Chope, 2014).

Among physical mutagens, X-rays and gamma rays are most often used as mutagens in induced mutagenesis. Over the past 40 years, the use of gamma rays in mutation induction has become particularly common, while the use of X-rays has declined significantly. This is probably due to both their wide availability and universality of use. Over the past century, gamma sources have been installed at several types of irradiated facilities. While many applications have dual or multiple uses, such as medical purposes, mutation induction, and food irradiation, some specially designed devices have been built specifically for the induction and use of mutations, such as gamma phytotrons and gamma fields that can be grown and irradiate plants chronically (not quite clear arrangement of phrases (Cheng et al., 2015).

The gamma irradiation unit can be used for single or chronic exposure. Single-action gamma devices are most common. As of 2004, there were about 200 gamma elements used worldwide specifically to induce mutations in plants. The gamma radiation source has a clear advantage for long-term use because it can be placed in a controlled chamber, greenhouse or field so that plants can be irradiated at different times and at different stages of development (Ceballos, 2007).

The effects of gamma rays on seeds can lead to many types of chromosomal damage. On the example of winter wheat varieties, chromosomal variations such as centromere breaks, chromosomal terminal deletions, deletions of one chromatid arm, and chromosome fragments occur. All appeared in the M1 metaphases of the meristematic cells of the mitotic root. In meiosis M1, irradiation led to the appearance of lagging chromosomes, ring formations. In the mitosis of M2 plants, some of the root meristematic cells maintained a normal euploid (2n) chromosome set, but some of them were aneuploid (Carlos, 2000).

At the same time, chromosome segmentation, terminal deletions, lagging chromosomes, chromosome bridges, and uneven segregation are observed in some metaphase divisions. Cytological abnormalities caused by ion beam irradiation can be corrected using chromosomal manipulation techniques. Aneuploidy is a major case used in plant genetics and breeding, particularly polyploids in crops such as wheat. There are quite a few types and varieties of aneuploidy induced in hexaploid wheat, diploid and tetraploid rye with extra chromosomes and rye due to chronic irradiation. Also, numerous cases of aneuploidy were obtained in M2 generations for all three types (hexaploid wheat, diploid and tetraploid rye). The majority of aneuploidy occurred due to the loss of one (2n-1) or more chromosomes. In some cases, loss of a chromosome arm has resulted in telomeric (t) chromosomes (Bonnot et al., 2017).

The biological consequences of radiation (abnormal cell division, cell death, mutations, impaired development of tissues and organs, reduced plant growth) can manifest themselves at various stages of development. The effect depends on the type and dose of irradiation, physiological state and genetic composition of the treated material. The effect on cell division and plant growth is determined by the fact that plant cells can quickly respond to radiation treatment and initiate mechanisms to combat the genomic consequences of such an action. Most radiation-induced DNA damage must be repaired before cells can start dividing again (resuming the canonical cell cycle). Severe irreversible damage can lead to lethal consequences, while less severe damage can be correctly or incorrectly repaired and lead to delayed cell division, cytological abnormalities and induced mutations. The destruction of many enzymes by radiation also slows down cell division and plant growth.

Depending on the dose, several types of cellular effects can be observed. The most likely is cell death. It can occur through apoptosis, in which radiation triggers a genetic process of programmed cell death, cytolysis (swelling of cells until they burst and disappear), protoplasmic coagulation (irreversible formation of gelatin in both the nucleus and cytoplasm), karyolysis (swelling of the nucleus with subsequent loss of chromatin), pyknosis (nuclear shrinkage and condensation of chromatin) or karyorexia (nuclear fragmentation) (Boyd et al., 2006).

At non-lethal doses, changes in cellular function may occur, including delays in certain phases of the mitotic cycle, impaired cell growth, changes in permeability, and changes in motility. Mitosis can be delayed or inhibited after exposure, causing severe changes in the kinetic patterns of cells, leading to depletion of the affected cell population. Dose-dependent inhibition of mitosis (reduced mitotic index) is particularly common in actively proliferating cell systems, such as meristems. This inhibition occurs when chromosomes begin to condense at the beginning of the prophase of the mitotic cycle, but before the breakdown of the nuclear membrane. Further exposure after this transition point does not delay mitosis (Bottino et al., 1975).

Ionizing radiation causes cytological aberrations and chromosome separation defects. Cytological aberrations observed in mitosis include the formation of micronuclei and chromosomal abnormalities. Micronucleus analysis measures the proportion of micronuclei formed by a given dose of radiation. It is a sensitive test for investigating radiation-induced cytogenetic damage in dividing cell systems in vivo. Chromosomal abnormalities in irradiated mitotic cells range from breaks, through exchanges, lags and anaphase bridges, dicentric and centric ring formations, terminal fragments with the presence of a telomere at only one end, and interstitial fragments that appear as double fragments without any telomeric remnants (Bordes et al., 2011).

Chromosome separation defects play an important role in the formation of genomic instability and aneuploidy. Merotelic orientation of kinetochores is the main cause of chromosome lagging during mitosis. Cells with monooriented chromosomes never enter anaphase, and lagging chromosomes appear during anaphase after chromosome alignment occurs during metaphase. Cell growth may also be slowed, usually after a latent period. This may be due to the progressive formation of metabolic inhibitory products and/or changes in the cellular microenvironment. Irradiated cells can show both increased and decreased permeability. Radiation changes in lipid bilayers of the membrane can change ion permeability. This may be due to changes in the viscosity of the intracellular fluid associated with a disturbance in the ratio of bound and unbound water. Such changes will disrupt the cell's ability to maintain metabolic balance and can be very harmful, even if the shift in balance is small. Cell motility may be reduced after exposure. However, the presence of normal motility does not mean the absence of radiation damage. Irradiated germ cells, for example, may retain their motility and be capable of fertilization, carrying radiation-induced genetic changes that may affect subsequent embryogenesis (Bordes et al., 2011).

Meiosis is a more complex process involving DNA replication, cell division, genome reduction, chromosome recombination and rearrangement, and is easily disrupted by radiation. An increase in the radiation dose is positively correlated with a decrease in the meiotic index. Mutant plants usually show reduced fertility, caused mostly by chromosomal rearrangements and genomic mutations during meiosis. Chromosomal aberrations include reciprocal translocations, duplications, deficiencies (aneuploidy), and inversions. Ionizing radiation significantly affects physiological and biochemical processes in plants. Irradiation of seeds disrupts protein synthesis, affects hormonal balance, disrupts gas exchange, water exchange, and enzyme activity. Morphological, structural and functional changes depend on the intensity and duration of the induced radiation stress. In the case of moderate stress, plant adaptability is preserved and the observed changes are reversed. In general, seed germination, plant growth and reproduction are inversely correlated with the radiation dose.

Ionizing radiation can cause various biological effects. Radiosensitivity measures the relative susceptibility of organisms, organs, tissues or cells to the harmful effects of ionizing radiation. Highly metabolically active cells, rapidly dividing cells, and undifferentiated cells are most sensitive to radiation. Any cells passing through different stages of the cell cycle are most sensitive to gamma rays in the M phase stage and less sensitive during the G2, G1 phases and least sensitive in the S phase. Thus, as a rule, dividing tissues, are radiosensitive (high mitotic rate) and non-dividing tissues are radioresistant, so reproductive cells/tissues are affected more than undifferentiated cells/tissues.

Most of the effects occurring in the M1 generation are physiological. Damage to plants in the M1 generation indicates the degree of mutagen exposure to plants and can be quantified in various ways. Physical injury is usually measured by parameters such as reduced seed germination, seedling growth rates, germination vigor, sterility, and even plant mortality. They can be used as synthetic indicators to establish threshold values of mutagen doses to obtain the required mutation induction.

Seedlings are particularly sensitive to mutagens and are a simple indicator to measure the effect of a treatment. Seedling height and root length are easy parameters to register. Seedling height is usually used as an indicator of genotype response to gamma radiation, and depending on the species, different methods can be developed to show the decrease in seedling growth with increasing dose of gamma irradiation in different genotypes with different levels of radiation tolerance. Thus, the worst-resistant genotypes have relatively poor germination and seedling development compared to wild forms that show high resistance when treated with the same high dose of gamma rays (sometimes up to 500 Gy), indicating that wild forms are more tolerant to gamma rays. According to the simplest method of measuring the height of shoots and the length of roots, cereal seedlings are placed on a sheet of millimeter paper, on which the lengths were previously marked.

Mutagens can completely prevent seed germination at high doses. Mortality, where seeds germinate but fail to grow and eventually wilt and die, is also common at high doses. High doses of gamma rays can also reduce the fertility of M1 generation plants and in extreme cases can lead to complete sterility. Since there is a direct relationship between plant response and mutagen dose, germination and survival rates, and fertility reduction, they can be used to determine optimal doses of mutagens for plant treatment. While germination rates are calculated at an appropriate interval soon after sowing, survival rates are determined at maturity (at harvest) of the M1 population. Plants that complete their life cycle and produce at least one inflorescence or flower, regardless of whether seeds are formed, can be considered survivors after treatment. The actual death of the plant can occur at any time between emergence and maturation. Survival rates determined in controlled environments can differ significantly from field trials, especially if adverse conditions occur.

A decrease in the fertility of plants of the M1 generation can manifest itself in various forms. The degree of M1 sterility varies greatly from plant to plant and spike to spike, even within a population treated at the same dose. Seed similarity is the criterion most often used to quantify sterility. Due to the wide range of variation among plants, a sufficient number of spikes should be used to estimate this parameter.

The induction of artificial biodiversity quite effectively changes the plant organism both in terms of modernization of individual features and for the creation of fundamentally new forms with complex changes that have no analogues or in which correlations with other negative parameters are broken. Altered traits quite often have analogues among wild or related forms, but the use of these analogues is complicated by the imperfection of methods of introgression of certain combinations of genes by methods of classical selection. Quite often, key traits useful for economic use are recessive and polygenic in nature.

The leading methods of using the mutation process are, firstly, the preparation of initial components for classical breeding with such improved individual valuable traits as short stemness, maturity period, fullness of seeds, resistance to the harmful effects of biotic and abiotic factors of the environment, high grain productivity and excellent technological qualities of grain (protein and gluten content, composition of reserve proteins with valuable subunits). Sometimes it is possible to achieve complex or synergistic improvements that have a systemic nature and strengthen the hybrid power of the obtained material. Another direction is to eliminate the connection between positive economic signs and negative ones without worsening the former.

Induced biodiversity of cereals is quite often used for the direct creation of new commercial varieties and hybrids, which is possible due to the direct effect of gamma rays. This method made it possible to introduce a new intensive variety into agricultural practice.

The use of high and sublethal doses of gamma rays also led to the production of numerous mutants resistant to diseases and abiotic stresses.

Irradiation of hybrid seeds is used to strengthen the heterosis power, which leads not only to the intensification of the shape-forming process, but also to the appearance of fundamentally new economically valuable traits, strengthening the recombination of chromosomes. The yield of useful forms from hybrids treated with mutagens is almost twice as high. The offspring of hybrids are more mutable than the parent varieties.

The use of mutagens in combination with recombinogenesis is more effective for creating lines of winter wheat resistant to diseases and salinity, which has been proven by world practice.

This was confirmed when a salt-resistant wheat variety H6756 was obtained from a mutant-recombinant population, which demonstrates high yield under salinity conditions. Research is ongoing to find new mutagens and combinations of mutagens characterized by significantly less mutagenic depression at the same level of formative activity. Space and ion beam radiation are promising. When studying the effectiveness of space in inducing new forms, it was found that compared to gamma rays, it induces significantly more useful lines.

It has been established that the optimal combination of the mutagenic factor, its dose and the specificity of the genome structure gives a several-fold increase in the frequency of economically useful mutations, which also have a higher adaptation to environmental conditions.

The use of genetic instability in combination with the action of gamma rays is also able to significantly increase the efficiency of the mutation process, and is probably the most effective tool (not counting genetic transformation) for breaking the connections between individual traits in genetic systems.

Selection of mutant traits is usually practiced for quality traits in self-pollinated crop plants in the M2 generation, since most mutants are recessive by then. Thus, the mutant phenotype can only be seen in the M2 generation. However, in cross-pollinated plants, the mutant genes are likely to be heterozygous until M3, where further selfing should be practiced to produce progeny in which individuals homozygous for the mutant genes will segregate and selection can be applied. However, a useful strategy for outcrossing species is to breed the dominant allele at heterozygous loci to reveal the recessive phenotype.

Progeny tests are essential to identify all mutant lines useful for plant improvement and reselection from the M3 generation; this is done to establish that the trait is hereditary. Further tests may be needed to stabilize a potentially useful variant. In addition, it is not uncommon for a mutant to be homozygous for a desired trait but segregate 37 for other undesirable ones, which can still be selected for when their selection may be beneficial in improving the genetic pool of the desired mutant. In rare cases, a mutant may result from the modification of the epistatic relationship of more than one modified locus; in such a case, the M2 mutant phenotype may not reappear among the M3 progeny. If the phenotype is the result of an interaction involving a heterozygous locus, then it cannot be fixed in the inbred line, which may explain the disappearance of the phenotype between the M2 and M3 generations. If this is the result of interactions between independent loci that have been lost due to independent gamete assortment, then reversion to M2 and selection of a larger M3 should facilitate phenotype detection and eventual fixation.

In some situations, tests on M3 progeny may be important for detecting mutants, especially those that are difficult to recognize from individual (M2) plants. This may be particularly true for traits that are influenced by the environment, such as pigmentation and some biochemical or physiological mechanisms. When the number of seeds per plant, ear, etc., in M1 is low, it is desirable to grow an M3 population from all M2 plants and sow these plants, since in some practical cases up to 60% of the total number of mutants is observed for the first time in M3. The frequency of mutant individuals in the unselected population is usually higher in M2 than in M3, but space requirements and other considerations make screening for mutants only in M2 more cost-effective. Genotypic screening (eg, for a mutation in a particular gene) in M2 is more efficient than phenotypic screening, which may be influenced by the environment, but obviously requires knowledge of the gene in question and an efficient system to detect mutations that can lead to phenotypic changes.

It is also possible to use mutants obtained under the influence of anthropogenic load in certain areas. Thus, the Chernobyl Nuclear Power Plant zone, where many promising varieties of winter wheat are obtained, is effectively used. As a result of the study of genetically unstable mutant lines of wheat, it is shown that the selection of unstable mutations makes it possible to achieve a positive shift in productivity and increase grain yield.

The mutation process is effective in creating forms with new useful biochemical complexes. Thus, as a result of the use of new mutagens, 4 mutant forms of wheat were created - in two of them there were changes in the synthesis of the Wx-B1 protein, in the others - in the WX-D1 protein; in four durum wheat mutants, in one case - in the synthesis of Wx-A1 protein, and in the others - in the synthesis of Wx-B1 protein. A genotype of ultra-strong wheat was created with a combination of subunits 5+10 (Glu D1) of glutenins and the absence of subunit 20 (Glu B1). The mutant line was characterized by the following changes: a stronger stem, wider leaves, a larger ear and higher grain size.

According to the results of testing new mutant sunflower lines, it was established at the molecular genetic level that the high nutritional quality and modified composition of fatty acids are caused by a mutation in the FAD2-1 locus. A suitable molecular genetic marker was obtained for the identification of similar changes.

When using mutagens in in vitro selection to create chimeric forms, it is necessary to combine cell selection with the action of gamma rays to increase the yield of useful mutations. This is of particular importance in the case of mutational improvement of some vegetatively propagated useful crops with the widespread use of sectoral vegetative changes and chimeras.

Climate change is the cause not only of a global temperature rise, but also of an increase or decrease in the amount of precipitation in a certain region. Water scarcity has a negative impact on agricultural production, and this is especially acute in developing countries. Cultivated plants cannot grow without water, it is necessary for all stages of the development of agricultural crops - from germination to vegetative growth and periods of reproduction (development of fruits and seeds), so the creation of drought-resistant mutant forms is crucial. There are two ways to develop new mutant varieties with salinity tolerance and high drought tolerance: one is to mutagenize a variety that is high-yielding but susceptible to salinity and drought, and the other is to mutagenize a variety that is low-yielding but salinity- and drought-tolerant, e.g. , a traditional local variety grown in this region. In this case, since it is much easier to improve agrotechnical performance than to increase tolerance to salinity and drought, the latter is the better option. However, in such a situation, it is important to carefully select the best mutagen and technology to achieve this particular breeding goal. The final step is to deploy an efficient screening and validation method for mutants. As with all mutation selection programs, after selection it is important to test and confirm that the selected mutated trait is heritable.

Thanks to the program for genetic improvement of basic biochemical metabolic processes that ensure plant productivity, fundamentally new forms with valuable biochemical components, increased efficiency of photosynthesis, resistance to abiotic stresses, and features of the structures of individual plant organs were created; obtained numerous sources of these features.

The analysis of literary sources confirmed the relevance of studying the specifics of the effect of different doses of gamma rays on varieties of local selection. Gamma irradiation is currently the most effective known method for creating adaptive forms.

Research on ecological genetics and induction of cereal biodiversity is based on the use of a fairly wide range of doses, which mainly depends on the subject of mutagenic action - that is, the genotype and physiological activity of the organism. This phenomenon is determined at the fundamental level.

Studies on the induction of the mutation process have shown the importance of using local varietal resources as already adapted material for given environmental conditions. In general, it is much easier to improve the quality of grain or the yield in case of imperfection according to these indicators of local forms than to improve the set of traits that determine tolerance to environmental conditions in a specific region. This position is proven by a large amount of data from two implemented international programs and numerous national studies.

Under the influence of gamma rays, such features as depressive effects in the first generation and preservation of the shape-forming process at the same level without reducing the depressive effects in the first generation are quite difficult, but possible with the selection of the correct "dose of mutagen - genotype of the original form" system. Moreover, the priority in the system belongs to the genotype indicator, and the reaction system itself to the action of gamma rays has a recessive character.

The influence of physical mutagens (gamma rays) on the ontogenesis of individual plants is traditionally not positive and is expressed in problems with the normal processes of plant growth and development, the slowing down of certain phases of vegetation, their onset later than in the control (sometimes up to a decade or more for individual phases earing - ripeness), reduction of germination, survival of plants, fertility, presence of various morphoses. Even an insignificant, at first glance, one-time action of mutagens on seeds significantly corrects the survival and productivity of the winter wheat plant.

Mutagenic depression is the presence of a noticeable decrease in vitality in the first generations of plants after treatment with a mutagenic factor. A considerable number of signs have been identified that can be used to show the degree of its manifestation, but the most widely used are germination and survival (the latter is critical, first of all for winter crops), pollen sterility, the structure of 10-day seedlings, elements of architecture and yield, biological and economic productivity of plants. In part, these signs are duplicated during observation, and some of them, depending on the genotype of the object of mutagenic action and the peculiarities of the course of ontogenesis, are not reliable for a full assessment of the phenotypic variability of the aftereffect.

The activity of the mutagenic factor in the first generation is manifested when observing a decrease in viability, fertility, various morphological and physiological damages at the level of the plant as a whole. Physiological injuries are not rare, which actually determine the limits of the use of doses and concentrations in practice. The influence of a single mutagenic factor is identified by the viability of plants of the first generation in field studies.

Manifestation of mutagenic depression depends entirely on several factors. Firstly, from the subject of mutagenic activity and his life state. If we use dry seeds as a subject, the mutagenic depression is lower; for soaked seeds, seedlings, pollen increases with each gradation of the material. This is a significant limitation of the amount of the mutagenic factor. The second parameter is the nature of the active factor - gamma radiation, as is typical for physical mutagens, according to the specifics of the action, it belongs to mutagens with a high manifestation of depressive effects.

The question of a significant reduction in the negative consequences of depression at the same level of mutational variability (frequency and spectrum of mutations) is quite relevant, in addition, some researchers have established that there is no direct relationship between the depression of the organism in the first generation and mutational variability in subsequent ones. Two possibilities are considered to be the main ones in this direction: the search for factors new in nature (laser, irradiation with carbon nitrogen ions, use of outer space), which lead to the same level of mutational variability with a significant reduction in the negative consequences of depression, and the use of stabilizing antimutagens that reduce the activity active factors. But the consequence of the second option quite often is an undesirable decrease in variability.

By acting on dry seeds of winter wheat, mutagens primarily affect those signs that begin to form at the time of action. This is mainly reflected in the parameters of ontogenesis (similarity, survival, onset of individual phenophases), elements of the yield structure in the first generation of plants. Depending on the nature, mutagens are able to exert a depressing or stimulating effect on the ontogenesis processes of plants of the first generation. Mostly, mutagens have a depressive effect on the signs, especially in the case of high doses and concentrations. The study of the first generation of plants of certain varieties is necessary, since the depressive effects in the first generation determine the amount of source material for detecting mutational activity in subsequent generations, reproduces the nature of the mutagenic factor, 60 is related to the frequency and spectrum of hereditary changes in subsequent generations, and determines the ability to manifest dominant changes.

Results. The monitoring parameters for the degree of mutagenic depression in the first generation of plants of varieties that received a mutagenic effect were: indicators of plant ontogenesis (similarity, remote death), pollen fertility-sterility and individual elements of the yield structure (plant height, grain mass from the main ear, grain mass from a plant, weight of a thousand grains). The genotypic feature of local varieties turned out to be quite sensitive to the action of gamma rays. Accordingly, this is an indicator of their fundamental feature under the influence of gamma rays for obtaining a high level of mutational activity in the future and indicates a possible high level of mutability in terms of the frequency and spectrum of further changes, i.e., these genotypes are quite promising for the manifestation of depression in the first generation.

Significant parameters of variability at the level of the cellular apparatus are the general frequency of chromosomal aberrations, the frequency of bridges, and the frequency of complex rearrangements. The ratio of fragments to bridges corresponds to the standard patterns characteristic of gamma rays.

The use of local material as a starting point for mutational improvement is effective in view of obtaining high-intensity stunted and semi-dwarf forms, with a long pointed ear and a wax coating.

A high probability of changes with a wide range of doses can be obtained by actions on key features for plant architecture. The key features of 145 mutational variability of winter wheat with regard to the correct assessment of the population exposed to gamma rays were: the height of the stem, the presence of a wax coating, and the maturity period. Other options for changes in useful features are of medium and low probability. For the mutation process, such indicators as a tall stem, a low stem, a semi-dwarf, an intensive wax coat, a weak wax coat, a spiny ear, a thornless ear, a long ear, a large ear, sterility, late maturity, early maturity, bushiness, productive, speltoid ear are modeled.

Varieties Gallixe, Ghayta, Courtiot, Spivanka are the most promising both for use in the formation of permanent high-yielding and high-quality agrocenoses of winter wheat in the conditions of the northern Steppe of Ukraine, and as initial forms. Commercial, Geo, Gallixe, and Renan varieties are partially worthy of attention (according to certain parameters for improvement). Lines 123, 152, 179, 181, 262, partially lines 179 and 213 can be recommended for the complex of yield and quality characteristics. All lines, except 213, belong to the intensive type.

The level of variability is a more reliable and comprehensive indicator for evaluating the effectiveness of the combination of the genotype of the source material and the dose of gamma rays. Optimal for increasing grain productivity and quality is the use of doses of gamma rays in the range of 100-150 Gy, but success in this case also depends on the quality of the source material.

The mutation process with regard to increasing grain productivity is effective due to the effect on such characteristics as plant height, weight of grain from an ear, weight of grain from a plant, ratio of constituent components of reserve proteins of grain. In connection with changes in local climatic conditions, such traits as early maturity and winter hardiness do not provide the necessary advantages from the point of view of realizing the productive potential of agrocenoses of winter cereals, so they do not require the presence/further improvement of cereals and do not require the presence/further improvement.

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