

Study of Pollination Type Role in the Manifestation of Genome Genetic Instability in *Nicotianatabacuml.* Cells



Science

KEYWORDS : *Nicotianatabacuml.* genome instability, chromosomal aberrations, ionizing radiation.

Sevil Mamedli

Institutes of Radiation Problems NAS of Azerbaijan, Baku
31a, H. Javidave., Baku, Azerbaijan

ABSTRACT

Radiation-induced genomic instability in Nicotianatabacumlplants was studied. Increase in the number of chromosomal aberrations of the plants of M1 and M2 generation was shown. Level of the chromosomal aberrations depended on the exposure dose and pollination type.

Introduction.

Genetic instability manifests as increase in the rate (frequency) of genomic changes formation which occur both, spontaneously and under different factors. Nevertheless, mutations may occur not just after stress factor, but following ten replication cycles (replicating instability) [3, 4, 5]. According to some data, up to half of all mutations can appear in the form of replicating instability [3].

As the result of genetic instability induction, genetic structure of the populations changes, and their heterogeneity increases in terms of different characteristics. Increase in genetic instability has controversial value –both can take place, decrease in viability of the certain individuals and increase in their resistance to the damaging factors providing the base for subsequent selection of the appropriate individuals under sufficient power and action time of the stressor. It produces the base for accommodation–process of the increase in adaptation to the changed living conditions and enhancement of the resistance to the effect of different stressors. In this case, increase in the rate of mutations and other genomic reconstructions have the adaptive value, and populations adaptiveness, their persistence and reliability increase proportionally to the degree of genetic variability to the limited extent. While the opinion about negative role of the genetic instability in animals and human is based on the fact of significant contribution of the genetic instability to the processes of cellular malignant transformation, then its adaptive value is more evident in plants and microorganisms.

The objective of this paper was to observe the existing forms of the genetic instability in the cross-pollinated plants under normal and stress conditions, to search for main characteristics and consistency of its manifestation, possible mechanisms, as well as the role of genetic instability phenomenon for plants at the different organization levels (molecular, cellular, organism, and population).

The objective of this study was to establish radiation-induced genomic instability in *Nicotianatabacum L* plants and correlation of its manifestation with pollination type. In order to study induction of manifestations of genetic instability in the subsequent generations of plants by ionizing radiation, *NicotianatabacumL.* seeds were previously exposed to radiation in doses of 1, 2.5 and 5 Gy, followed by plants cultivation throughout three generations [1, 2, 6].

Objects and methods. Exposure of seeds was conducted on the apparatus "Issledovatel" (^{60}Co) with dose rate of 0.02 Gr/sec, and on the apparatus "Ruhund" (^{60}Co) with exposure dose rate of 0.5 to 1 Gr/min. Control and exposed seed were couched on the wet absorbent paper in the Petri dishes at 30-32°C Part of the germinating seeds was used for cytogenetic analysis, and the rest of the plants were cultivated under the laboratory conditions, with further planting on the field. For measurement of the radiation-induced genomic instability level, number of the chromosomal aberrations was calculated in the root meristem of M_0 , M_1 , and

M_2 generations of the germinating seeds. In order to study the impact of cross-pollination on the level of genomic instability in plant generations, part of the adult plant inflorescences which were grown on the field, was isolated with protective caps preventing cross-pollination and, thereby, providing forced self-pollination.

Results and discussion. Impossibility to isolate genetic apparatus of the organisms from different environmental stresses, such as ionizing radiation, predetermines necessity for additional inducing of biological capabilities of the organisms, which allow them to adapt to the effects of these biosphere components. This can be achieved with regulations of organisms resistance, bioactive compounds. It is known that protectors act via correction of cellular metabolism processes by their induction or inhibition [1, 6].

Evaluation of CAs (chromosomal aberrations) development in M_1 and M_2 generations of the tobacco plants, obtained from singly exposed seeds showed that CA development is always dose-dependent, gradually increasing with the increase of the exposure dose. Significant differences between variants with cross-pollination and self-pollination were detected in both generations [fig.2, 3].

When comparing the number of structural chromosomal changes in variants with cross-pollination in M_1 and M_2 generations, it can be seen that approximately 1.3-fold decrease in CA number takes place for all exposure doses. In case of the self-pollination, decrease in CA number also occurs in the second generation, but to the less extent, remaining at the fairly high level.

Therefore, upon study of the CA development and plant growth in three succeeding tobacco generations, cultivated from the seeds which were exposed to different acute radiation doses at baseline, it was shown that increase in CA development takes place which is not kept in the subsequent generations. Obtained results can be considered as the evidence for radiation-induced genomic instability in tobacco plants, which degree of manifestation depends on the exposure dose and pollination type of the plants [fig.1,2].

Also, it was shown that radio-induction effect is accompanied with changes in the intensity of many physiological processes – photosynthesis, assimilants transportation, accumulation of the substances in the cells, biosynthesis reinforcement (nucleic acids, proteins, and other compounds), increase in activity of some enzymes, modification of the phytohormonal balance; increased permeability of the cellular membranes is also observed [2-5]. However, these processes cannot be considered as the primary, whereas they result from change in functioning of the regulatory body systems. Seeds exposure significantly increased CA development in the root meristem of the M_0 generation germinating seeds (fig. 2.), provided that maximum effect was observed at the exposure dose of 2.5 Gy. Study of the time course of the growing processes in the field plants showed the loss of the induction

effects and inhibition of the sprout growth in plants of the radiation-exposed variants during vegetation.

Therefore, established increase in CA number in generations of the descendants of dicotyledon representatives obtained from radiation-exposed seeds has a nature of the comprehensive trend, and can be regarded as manifestation of the radiation-induced genomic instability in the plants.

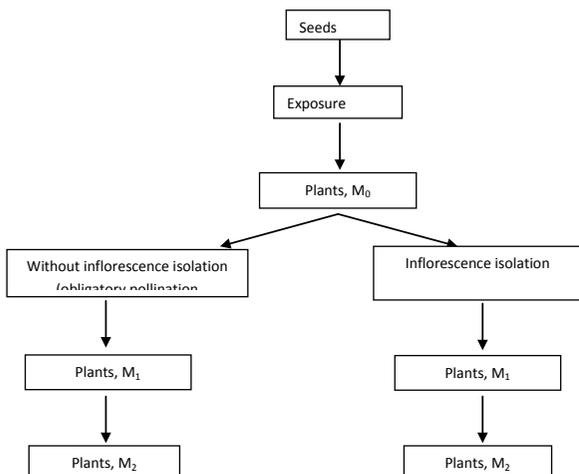


Fig.1. Chart for study of the chromosomal aberration development in generations of the radiation-exposed plants

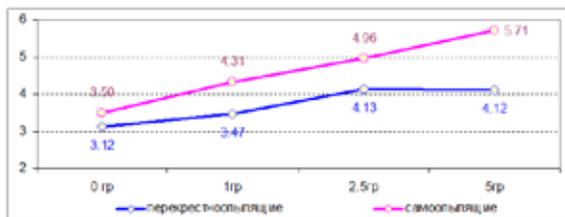


Fig.2. Development of the chromosomal aberrations in the root meristem of M1 generation of the Nicotianatabacum germinating seeds under cross-pollination and self-pollination. On the X-axis – exposure dose, Gr; on the y-axis – aberrant cells rate, conditional units.

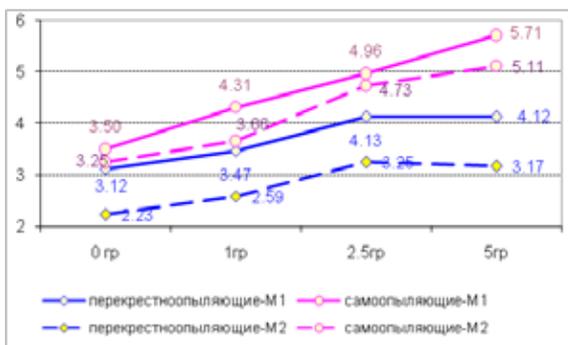


Fig.3. Comparative analysis of the chromosomal aberrations formation in the root meristem of M1 and M2 generations of the Nicotianatabacum germinating seeds under cross-pollination and self-pollination. On the X-axis – exposure dose, Gy; on the y-axis – aberrant cells rate, conditional units.

REFERENCE

1. Rank J., Jensen A.G., Skov B., Pedersen L.H., Jensen K. Genotoxicity testing of the herbicide Roundup and its active ingredient glyphosate isopropylamine using the mouse bone marrow micronucleus test, Salmonella mutagenicity test, and Allium anaphase-telophase test // Mutat. Res. – 1993. – № 300. – P. 29-36. | 2. Kunakh V.A. Genomic variability of the plant somatic cells. Variability and selection during accommodation to in vitro cultivation conditions // Biopolymers and Cell. – 2000. – 16, No. 3. – P. 159-185. | 3. Grebneva E.A. Molecular mechanisms of development of the base substitution mutations under post-replication SOS-repair of the double-stranded thymine dimers-containing DNA // Biopolymers and Cell. – 2001. – 17, No. 6. – P. 487-500. | 4. Braun B. Genetics of the bacteria. – M.:Mir, 1968. – p. 448. | 5. Morgan W.F. Non-targeted and delayed effects of exposure to ionizing radiation: I radiation-induced genomic instability and bystander effects in vitro // Radiat. Res. - 2003. - 159, N 5. - P. 567 – 580. | 6. Mamedli S.A. Radiation-induced genomic instability in plants and bacteria. Baku: Elm; -2007. P. 256.