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ANEUPLOIDS CYTOEMBRYOLOGICAL PECULIARITIES IN THE POPULATION OF SUGAR BEET DIGENOMIC SPECIES AS A SOURCE OF GENETICALLY RENEWED MATERIALS

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The embryology researches of tetraploid forms of sugar beet of many years identified the frequent display in their posterity of triploid and aneuploid plants with a different quantity of chromosomes [1].

In spite of the negative sides of aneuploidy, this phenomenon can be used in the genetic researches, especially in the objects with the good karyological structure of chromosomes for development of questions of theoretical and practical nature. Aneuploidy causes violations of genome composition of plants, that contributes to the deep cognition of their genetic structure. With the help of trisomic, haplosomic and nullisomic large researches on the study of genetic functions of separate chromosomes, features of action of genes and their alleles are conducted [2].

Work aim. To expose and conduct cytological researches of new genetically changed plants among posterity of tetraploid and aneuploid sugar beet with the purpose of their usage in the selection.

Research methods. The experiments were conducted on the base of Uman State Agrarian University (agrobiological station) and Institute of Bioenergy Cultures and Sugar Beet of NAAS (Kiev).

For the study were taken aneuploid forms with the unbalanced number of chromosomes 2p = 23, 2p = 28, 2p = 29, 2p = 30, 2p = 34, 2p = 35, 2p = 37, 2p = 38, 2p = 39, being selected from the tetraploid sort of Bila Tserkva origin and dihaploids 2п = 18 (reciprocal and reversible dihaploids from posterity of aneuploids). The processes of meiosis, gametogenesis and embryogenesis are studied. Simple tetraploids served as s control 2p = 36 improved by the quality of pollen 2p = 36 (type 1) and tetraploids 2p = 36 with the bad quality of pollen (type 2). Methods of accounting and cytoembryological analyses are conducted on the generally accepted methods [5].

The results of the conducted researches showed, that in meiosis of aneuploid plants there is a number of rejections in conjugation of chromosomes, which on the stage of diakinesis is expressed in formation, except for tetravalents and bivalents, univalent of chromosomes. The nature of conjugation of chromosomes determines passing further stages of meiosis. The presence of univalents in diakinesis leads to the violations of metaphase I, anaphase I and is accompanied by the disorderly dispersion of chromosomes and unsimultaneous their advancement to the poles. The chromosomes, thrown out in the cytoplasm, meet in interkinesis.

The blocking of work of spindle is observed, when the chromosomes are divided, but do not go to the poles, that results in formation on the stage of tetrad of microspores from 3 to 9 kernels.

During the study of gametogenesis in aneuploids with 28, 34, 39 chromosomes the wrong mitosises in the pollen corns were revealed. In the poles there are groups differing in the number of chromosomes; the quantity of spermium in the microspores increase to three-four or they are not formed. Sometimes in spite of twocellular gametophytes with the specific structure of vegetative and generative cells, two identical kernels appear, reminding vegetative. One of them is sometimes divided again with formation of three identical kernels differentiating only by the sizes. Spermium forming in such cases is not carried out. The size of pollen corns varies from 8,1 micron to 38,0 micron, from which small pollen grains are sterile. Diameter of fertile pollen grains without the obvious violations is within the limits of 20,0 – 26,0 micron, and on the average amounts 23,0 micron. Pollen corns which have a little spermium or microkernels, reach 28,5- 38,6 micron in the diameter.

After crossing aneuploid plants, genome violations caused by confluence of gamete with the number of chromosomes deviating from haploid or diploid, are observed. Confluence of two 18^{th} chromosomal gamete not equivalently to the confluence 19+17 chromosomal. In the second plant only seven chromosomes will presented by four homotypes, eighth will have five homotypes and ninth only three. If the formula of the first tetraploid plant is possible to present 9x4=36, the second 7x4+5+3=36. With the equal sum of chromosomes their genetic content is not identical, not only number of chromosomes plays the role but also their individuality, and also correlation of homological chromosomes. Such change can be occurred with any chromosomes of set and in any combination, that the spectrum of these forms varying determines. Genome violations in posterity of aneuploids are increasing, accompanied by the changes of gene balance depending on the quantity and correlation of their chromosomes. This is observed in posterities of aneuploid plants of stable on the chromosomes number, but different from ordinary diploids both on the external signs, and on stream of the generative processes. In case of such varying the plants with the good indexes are selected. So, in the sugar beet among aneuploids there is formation in their posterities of prevailing quantity of tetraploid plants (about 60% on the average). Quantity of, even most widespread, aneuploids with 35 and 37 chromosomes, does not exceed 7-16% and is equal on the average 15,5% and 23,7%.

More considerable violations are met in aneuploids embryogenesis, than in tetraploids, but in each of them, even small amount of seed achieves the normal morphological structure and physiological maturity providing a good germination.

In 8-12 hours after the beginning of flowering the number of zygote prevails in the diploid forms and improved tetraploid sugar beet. Arctic kernels that didn’t merged could be met in many aneuploids and in the initial tetraploid form, underdeveloped embryonic sacks – in aneuploids only. In aneuploids the interesting pictures of death of multicellular embryos, in which the cell membranes do not appear, and the kernels lie in the general cytoplasm, as in syncytium. Sometimes the general cytoplasm is absent, and the embryo cells lie isolated from each other, giving to him an extraordinarily dishevelled view. Such embryos before long die off and dry up.

Dying off of seedbud on the early stages of development is observed because of the underdevelopment of embryonic sacks or violations of pollination processes and impregnation. On the more late stages, on 8-12 day, when the embryo reaches the form of ball and formation of seed-lobe, there is a lag of seedbud in development, flowing with a different intensity depending on the genetic features of aneuploids. More or less considerable part of seedbuds reaches the full development.

On the stage of 16-29 days in the control and more than the half of embryos of the improved tetraploids reach the full morphological development, remaining still physiologically immature. The embryos with the seed-lobes from 1/4 to 3/4 length of embryonic sack prevail in aneuploids and there are still more backward seedbuds.

Most of normally developing seeds are observed in diploid and improved tetraploid sugar beet and only in them the defective embryonic sacks are not revealed. In studied aneuploids more than third of seeds reach the full development.

On 24-28 day in the control plants and improved tetraploids considerable part of embryos 95,0% and 86,0%, accordingly, reaches the full morphological and physiological maturity.

Many embryos of aneuploids fall behind in development degenerating on different stages. Often the embryos remain underdeveloped and defective with the shortened seed-lobes or reach only the spherical or heart-shaped form. The part of seedbud degenerates on more early stages. In the process of development of seeds; in aneuploids 2p = 28, 2p = 30, 2p = 35, 2p = 37, 2p = 38 nucellar embryony and polyembryony are observed. In one embryonic sack the chaff and apomictic embryos are formed. There is a formation of apomictic embryos situated lower than normal apparatus or degenerating one. In the embryonic sack one or a few large cages are revealed, from which apomictic embryos are formed. [3,4]. Often there is a formation of embryos ball shaped without suspensorium or nucellar embryos on the long pendicles. In the embryonic sack the formation of acellular fabric with the thick cytoplasm and large kernels is observed. On late stages of development in the overhead part of embryonic sack there are embryos facing a microsaw or lying sideways. It should be noted that not all apomictic embryos reach the full development, part of them die out. At the same time the exposure of forms of plants with the elements of apomixis and conducting selection among them can provide the strengthening of sugar beet propensity to the apomictic reproduction and excretion of donors of this feature.

In posterities of dihaploid plants (2p = 18) the typical biomorphological features as polyembryony are appeared and others, which allows to include them to apomict.

Parthenogenetic development of embryos is often observed also during valency crossing of tetraploids with diploids and triploids. As a result of these crossing diploids to 42,1% and tetraploids to 45,9% are formed in posterities. Genesis of diploids is occurred as a result of adventive embryony or apogamy, and genesis of tetraploids is conditioned by forming an embryo from zygote formed from confluence of ovules with the unreduced set of chromosomes and diploid pollen. The presence of unreduced ovules testifies to the presence in the sugar beet of propensity to agamospermy. [4]

Conclusions. In meiosis of aneuploid plants there are a number of deviations, that leads to forming of aneuploid gametes varying in the size and content of chromosomes. Frequently there is a degeneration of masculine gamete on the last stage of gametogenesis with formation, in spite of the ordinary threecellular pollen grains, binucleate and trinuclear pollen, insufficient to the impregnation.

The changes of genetic nature cause appearance of new plants among which the formation of individuals with the good morphological structure, high stability and high productivity is possible.

The revealed propensity of aneuploid and dihaploid plants to apomixis and conduction of selection can provide the strengthening of sugar beet propensity to the apomictic reproduction and excretion of donors, as new forms of plants for the selection work.

REFERENCES

1. Бормотов В.Е., Турбин Н.В. Экспериментальная полиплоидия и гетерозис у сахарной секлы. – Минск: Наука и техника, 1972. – 232с

2. Буренин В.И. Наследственные дифференцировки в роде Beta L. // Генетика, 1994. – т.30. – №12. – С.1593-1598.

3. Зайковская Н.Э., Перетятько Н.А., Ширяева Э.И., Ярмолюк Г.И. Апомиксис у форм сахарной свеклы // Апомиксис и цитоэмбриология растений, вып.4. – Саратов: Изд. Саратовского универс. 1978. – С. 39-40.

4. Сеилова Л.Б. Апомиксис у сахарной свеклы и его использование в практической селекции // автореферат дисс…докт.биол.наук. – Алматы, 1996. – 44с.

5. Ширяева Э.И. Методические указания по цитоэмбриологическим исследованиям в селекции сахарной свеклы. – Киев: ВНИС, 1984. – 62с.