

## THE USE OF THE HETEROSIS EFFECT DURING BREEDING OF TABLE BEET

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*New theoretical approaches of the selection of table beet are offered, the basis of which include parental genetic characteristics of components and new combinations of existing conventional methods. Accelerated methods of creating varieties Diy of variety type Eclipse, Bahryanny, Vital were developed. Methodological material on creating linear material for F1 hybrids is presented.*

**Key words:** a table beet, heterosis, the selection, method, line.

The table beet roots are the major source of dietary due to the contents of a large number of medical components. Therefore, the expansion of henoplazma of such valuable culture is one of the important scientific task. The development of methods of accelerating breeding can solve this problem, based on the fact that to obtain new genotypes of biennial crop we need 25-30 years. One of the effective methods today remains different modifications of hybridization in most of intraspecific. It was necessary for us to develop new selection schemes based on the positive effect of heterosis and genetic characteristics of the parental forms [1].

**Research methods.** The experiment was conducted (1999-2011) under the field conditions of breeding crop rotation of IVM NAAS using early spring sowing scheme between rows of 40 and 70 cm, seed rate of 12 kg/ha, area of accounting land of 5-20 m<sup>2</sup>, depending on the nursery [2]. Gibrization of plants was performed according to the free pollination on isolated areas. [3].

**The results of research.** Research on the use of heterosis on the table beet began at Skvyra Experimental Station, but the effect of its manifestation was fixed on the posterity creating only monogerm varieties. At the same time, similar work was carried out in the Institute, identifying in the varieties effect of heterosis, which was the bulk of synthetic selection. The genetic system of creating the raw material for heterosis based on the recombination of alleles. On the basis of heterosis were obtained sources of genetic variation from recombination of alleles crossing the initial forms. Thus, in the hybrid F<sub>1</sub> of a table beet created by crossing four varieties of Dutch selection of variety type Bordo, was observed a significant advantage of crop capacity over the maternal forms during the period of ripeness. The effect of heterosis amounted 20-28% by beam crop capacity and 19-29% - by the technical, which was approved during the creation of variety Diy.

The manifestation of heterosis in the first generation was observed in the hybrids from triple interbreeding. These hybrids were obtained by crossing the first generations of simple hybrids with the third grade. This phenomenon is put into the

creation of variety Bagryanyy. So, heterosis was one of the most effective events that after the obtaining intervarietal hybrids of the first generation with high effect of individual-ancestral selection, fixed in the progeny of fissionable populations. Typically, in table beet (20-30%) the greater effect of heterosis was observed, mainly in terms of yield, productivity, sugars and betanin content in relation to parental couples if they differed in origin, species and ecological reproduction of seeds.

In determining the nature of heterosis, especially of biological essence, was defined that during the years, manifestation of its effect varies and depends on the characteristics of the parental components that are involved in the hybridization and vegetation conditions. For a quick combination in the F<sub>1</sub> hybrid generation of complex of economically valuable features, correlations were considered. Thus necessarily took into account the genetic nature of parental pairs. In order to establish the genetic nature, analysis of the literary sources to determine the genomic content of a table beet with the presence of identification genes which control a particular feature (especially Rot - R) red peel of root with red head.

Phenotypic expression of induced genes in the collection and selection samples for the detection of genotypes during creating lines was analyzed. Was identified the presence of genes in newly created varieties of table beet, which, in most cases, were used as testers for obtaining first-generation hybrids (C - resistance to leaf curling, Cl - pigmented leaf, Cv - pigmented rib, L - long root, RR<sup>t</sup> - red peel of root with red head, ru - brown peel.

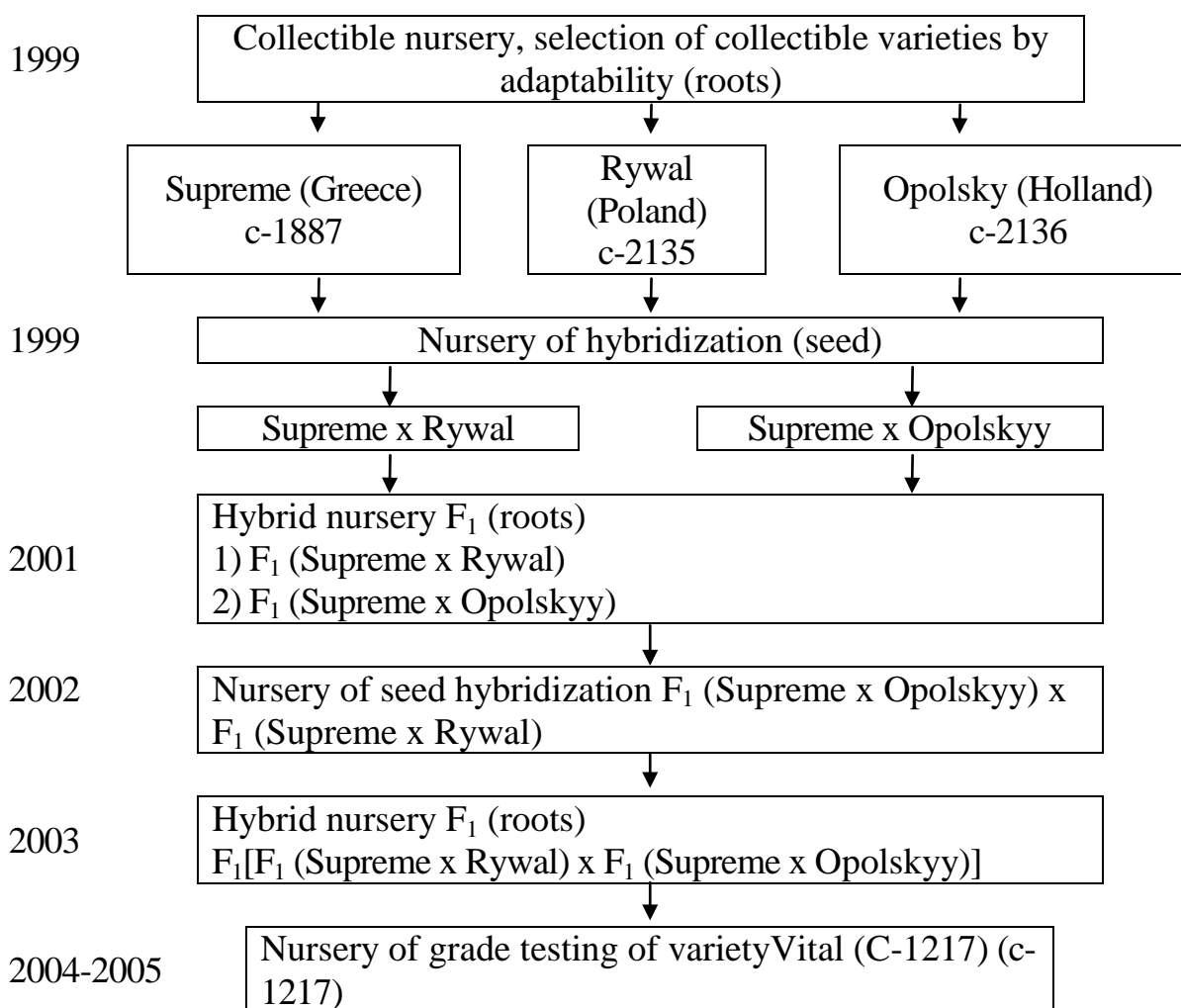
During expanding of heterosis breeding, particular attention was paid to: the increase of the genetically determined gene pool and the creation of lines with a complex of features; regularity of inheritance of economically valuable features of the collection and selection materials and the definition of donors for the selection; identification of parental forms with high general and specific combining ability, the value of which is controlled by the additive character of genes. The genetic effect of SCA opened out above the dominant, epistatic interaction of one parent genes. Analysis of the genome indicates that the features controlled by several genes with the effect of dominance, in its manifestation are more exposed to environmental factors, while features controlled by small number of the additive genes that are more resistant to stress conditions.

To determine the GCA and SCA were used direct and diallel reciprocal interbreedings of genetically distinct groups of lines and scale of Kobylyanskyy (2003). To get the hybrids F<sub>1</sub>, on the first stage of selection was used topcross method when - lines or varieties were crossed with adaptive-effective tester. Henceforth, was used the basic concept of the gene of complex features, selecting parental pairs (lines, grades) for hybridization by the genetic structure of breeding features. For passing to the posterity parental genes used grafting or false pleiotropic and, in most cases, the ability of a single gene to affect at the same time on several features.

Pleiotropy based on the correlation of features, which were separated into linear, curvilinear, positive, direct, and negative (inverse), simple and complex. If there is a positive correlation between the features, the gene necessarily affect the other, and they were inherited together.

In our practice during creation of varieties used convergent improvement when

a simple hybrid is backcrossed with parental forms and as a result, obtain two self-pollinated lines that are crossed with each other, and recurrent selection, which is based on intervarietal hybrid, from which select the lines with required characteristics, then pollinate, and then cross with each other. The most effective was reciprocal selection - from the hybrid intervarietal population or its derivative forms lay lines crossing with each other, obtaining simple hybrids, from which subsequently receive double one (Fig. 1).



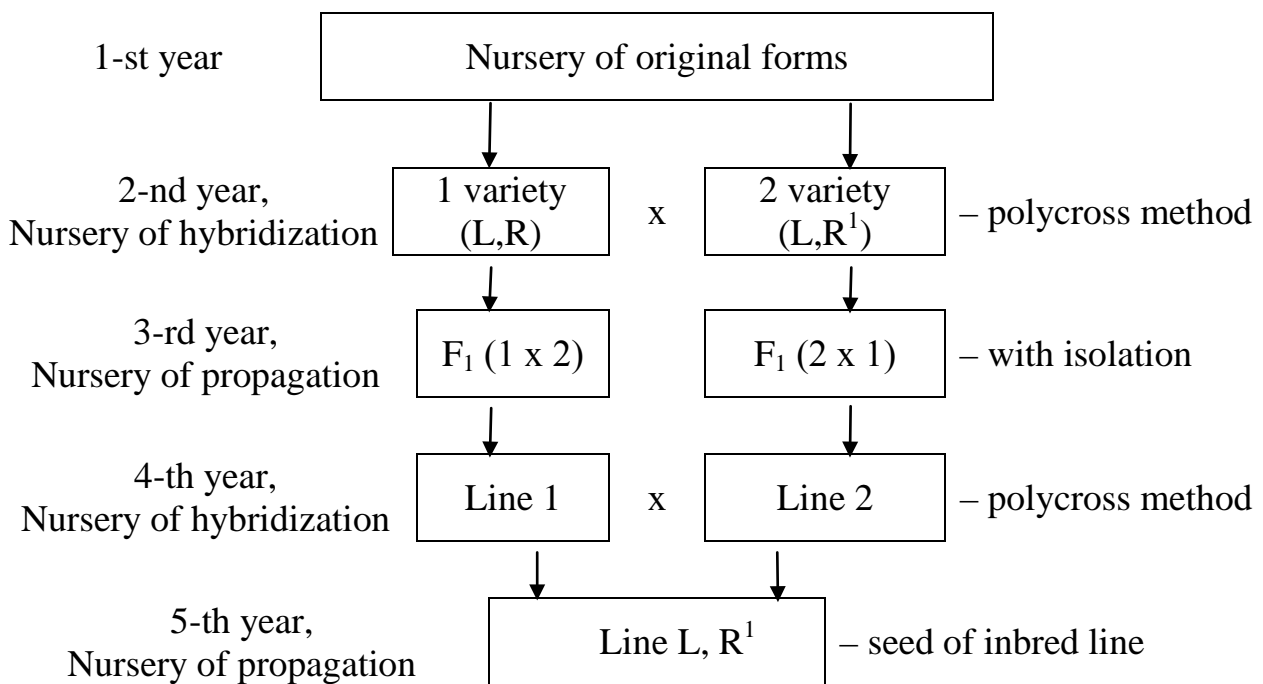
**Figure. 1. Selection process of creating the varieties of a table beet of cylindrical variety type**

The above mentioned methods were used in the selection process of creating variety Vital, which refers to the mid-ripened (vegetation period - 100-110 days). Variety has an upstanding outlet with 15-18 leaves, diameter of 39-43 cm, and height of 20-23 cm. Root has cylindrical shape 12-15 cm long with a diameter of 4-6 cm, tail length - 12-15 cm. Weight of root from 310 to 400 g, crop capacity - 33-35 t / ha, marketability - 87-91%. The dry matter content - 14-17%, total sugar - 8-9%, ascorbic acid - 13-15 mg %, betanin - 460-570 mg %, nitrate - 1341-2590 mg / kg.

During the selection work we have used the methods that are still in the process of creation. Efficient linear material was received using the Pedigree method, which

is based on progenies of interlinear hybrid with features that correspond to the direction of the new line. But this method is not fully guaranteed manifestation of heterozygosity. Linear material was prepared by the method of Miryuta, using parents of prospective interlinear hybrid. Then with the help of the individual reusable crossings of these lines received new.

Economically effective in heterosis selection is a top cross method using one tester and two self-pollinating lines. The effect of heterosis depended usually from a linear material with the corresponding genomic structure and combinations of interbreeding. The greatest strength was provided by genetically different parental pairs of table beet, not only from simple interlinear crosses, as well as trilinear ( $F_1 \times I_3$ ) - from hybridization (of simple hybrid with another inbred-line), double or four linear hybrids - from pollination of two linear ( $F_1 \times F_1$ ) and triple ( $F_1 \times F_1 \times F_1$ ) and four linear ( $F_1 \times F_1 \times F_1 \times F_1$ ). In the selection of table beet can be used the method of reciprocally-recurrent selection, where periodically recrudescence crossings are repeated at Figure 2.



**Figure. 2. Reciprocal-recurrent selection during creating lines of a table beet**

This method provides recombination of genes: L – long root and R - red peel of root.

In the process of creating lines of F<sub>1</sub> hybrids, different types of genes interaction were observed. They have been discovered by scientists-geneticists: complementary, mutually reinforcing; epistatic when two dominant genes belong to different allelic pairs of one organism, from the interaction of which one gene suppresses the other, and becomes the primary; polymer - interaction of genes of the same type that act on the feature in the same way.

It was found that the inheritance of root color was controlled by strong genes that provided the manifestation of heterosis. Subsequently homozygous lines can be

obtained from F<sub>1</sub> hybrid interbreeding with parental forms (backcrossing) (Table 1).

**1. The degree of yield dominance (t/ha) in F<sub>1</sub> hybrids of a table beet**

Parents, hybrid F <sub>1</sub>	2001	2002	Phenotypic manifestation of genes	
			the form of a root	the color of a root
♀ Supreme	33,9	40,4	Cylindrical, L	brown, ru
♂ Rywal	40,8	36,5	Cylindrical, L	red, r
F <sub>1</sub> (Supreme x Rywal)	60,7	66,4	Cylindrical, L	brown, ru
The degree of dominance (h)	6,7	14,03	Cylindrical, L	red, r
♀ Supreme	33,9	40,4	Cylindrical, L	brown, ru
♂ Opolskyy	40,0	44,6	Cylindrical, L	red, r
F <sub>1</sub> (Supreme x Opolskyy)	78,0	58,1	Cylindrical, L	red, r
The degree of dominance (h)	13,5	7,42	Cylindrical, L	red, r

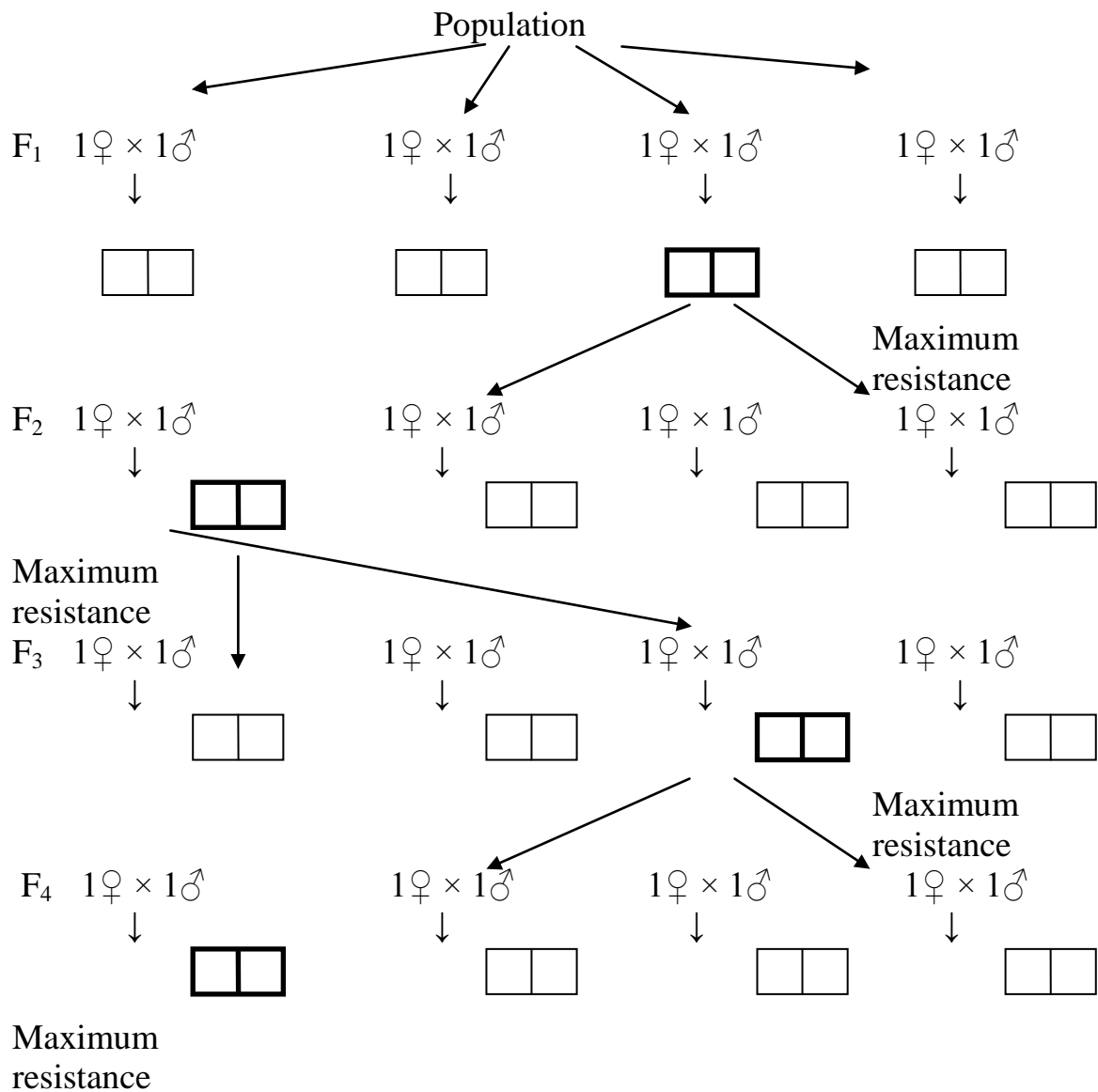
To obtain homozygous lines breeders in most cases provide inbreeding (inbred) of hybrids F<sub>1</sub>. Their genetic essence causes decomposition of the initial population on lines with different genotypes. Genes in them from the heterozygous state move into the homozygous. Also are used intrinsically linear and interline interbreeding (cross-breeding). To the successful receiving of lines contributes sib-selection. It is based on the method of individual selection from the progeny of hybrid populations and the presence of a maximum resistance in one of them (Fig. 3).

But hereditary properties with productivity of closely related lines are difficult to analyze.

In the institute using inbreeding were created homozygous lines of a table beet, with high betanin content, keeping qualities, resistance to stress conditions and diseases k 207,24. Obtained lines by hybridization with a free-pollinate tester - Diy variety, which has a genetic basis of keeping quality and precocity, provides a high total combining ability. During its determining, first used the method of the top cross, and specific combining ability - by incomplete diallel scheme.

Flash of heterosis in F<sub>1</sub> hybrids of table beet is provided by reciprocal crossings when testers - varieties Diy and Bordo Kharkivskyy are used first as a father with indirect repollination AA × aa, and with reverse - aa × AA.

Thus, an important moment during creating inbred lines from the initial forms remain stabilizing selections by quantitative features and selection by exclusion of undesirable features (ex-selection), which are based on the tandem selection by cycles on one feature to the consolidation in progeny, and others. It should be considered, especially in the initial hybrid forms, which method was used for hybridization. Thus, backcrossing is effective in selection for one or two features. Separately during creating lines of F<sub>1</sub> hybrids should pay attention to the primary process of selection - the selection of parental pairs.



**Figure. 3. Sib-selection during creating lines of a table beet**

Scientists hypothesized that there are three concepts of parents pairs selection: the concepts of variety, feature and gene. The concept of vatriety include a large number of cultivars for interbreeding and obtaining a significant number of combinations, which may include, in a small amount the perspective. The most effective is the concept of feature when theselection of pairs is held by their known characteristics, which can be combined in new varieties. Typically, hybridization is based on a large genetic divergence of parents and each of them has more positive or less negative features. In selection using the method of full backcross receive more positive features not from the donor but from the recipient (recurrent parent).

According to our data of the scientists chemists and biotechnologists on obtaining linear material affect growth regulators. Thus, for the acceleration uniformity of the last linear generations with increasing typicality and obtaining productively qualitative uterine roots, was proposed the method of processing table beet plants in the phase of 6-7 true leaf by gibberellic acid (GK<sub>3</sub>) 3 mg/l. It allows to increase productivity and typicality of uterine roots by 30 % and, thus, to ensure the

stability of the linear material. Similarly act growth regulators of EM-technology. On its basis, to increase the capacity and uniformity of lines, was proposed a method of seed treatment before sowing - soaking for 24 hours in a solution of the preparation Baikal EM-1U (1 ml/l).

**Conclusions.** The results of research presented methods based on the use of heterosis in breeding by separate regulatory genes, which doubly reduces the selection. New methods have already been tested during the creation of new genotypes of lines cC 207 and 24 and varieties Diy, Bahryanyy and Vital. It was proved that fixing effect of heterosis in progeny is possible by modification of traditional methods (bekross, polycross, inbreeding, converged sibso and reciprocally-convergent selection, method Pedigree, Miryuta and determination of the genetic characteristics of parental components).

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***Корниенко С.И., Горовая Т.К., Митенко И.Н., Стовбир О.П.  
Использование эффекта гетероза в селекции свеклы столовой***

*Предлагаются новые теоретические подходы ведения селекции свеклы столовой, в основе которых положены генетические особенности родительских компонентов и новые комбинации существующих традиционных методов. Разработаны ускоренные способы создания сортов Дейсортотипа Эклипс, Багряный, Витал. Представлен методический материал относительно создания линейного материала для гибридов F<sub>1</sub>.*

*По результатам исследований приведены способы, основанные на использовании явления гетерозиса в селекции по отдельным контролирующим генам, которые вдвое сокращают селекцию. Новые способы апробированы при создании новых генотипов линий кК 207 и 24 и сортов Дий, Багряный и Витал. Доказано, что закрепление эффекта гетерозиса в потомстве возможно при модификации традиционных методов (бекросов, поликроссов, инцухта, конвергентной сибсосовой и реципрокно-конвергентной селекции, методов Педигри, Мирюта) и определении генетических особенностей родительских компонентов.*

***Ключевые слова:*** свекла столовая, гетерозис, селекция, метод, линия.

***Kornienko S.I., Gorovaya T.K., Mitenko I.N., Stovbir O.P.***  
***The use of the effect of a heterosis in breeding of a table beet***

*Already offered new theoretical approaches for the selection of a table beet, based on genetic features of parental components and new combinations of existing conventional methods. Developed accelerated methods of creating varieties Eclipse, Bahrianyy, Vital. Presented teaching material concerning creation of a linear material for hybrids F<sub>1</sub>.*

*According to the results of research, methods are offered based on the using of phenomenon of heterosis in the selection of individual controlling genes which twice shorten the selection. New ways are tested in the creation of new genotypes of lines 207 and 24 kK and varieties Diy, Crimson and Vital. It is proved that the binding of the effect of heterosis in the progeny is possible with modification of traditional methods (backcross, polycross, inbreeding, converged sibsovoivoi and reciprocally-convergent selection, methods of Pedigree, Miryuta) and identifying of the genetic characteristics of parental components.*

***Key words:*** *table beet, heterosis, selection, method, line.*