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GENETIC GROUNDING FOR IMPROVEMENT OF FAGOPYRUM ESCULENTUM MOENCH BREEDING METHODS

Introduction.

Predominantly due to increase and stabilization of high crop yield by breeding methods the genetic potential of buckwheat production, its productivity could be advanced.

Solving this complicated task is possible by development and application of new and improving existing breeding methods, based on the species' evolutional-genetic and physiological features.

Academician M.I. Vavilov developed conception of species as a flexible morphological system that exists as populations, which are adapted (accommodated) to close conditions and have common adaptive (accommodative) characteristics [16].

Intra-species polymorphism as the result of evolution is characterized by two stages: the first is species establishment and development of its morpho-physiological structure, the second one is expansion of species areal.

The latter stage is especially important because the species splits to more and more differing ecotypes through mutations and recombination resulting in species polymorphism, while adapting to new conditions.

Areas of buckwheat origin are subtropical zone of South-Eastern Asia [15] and subtropical regions of Southern China [10]. Therefore its establishment as a species occurs with sufficient warmth and water, which caused strong competition in cenosis for light. By its survival strategy buckwheat belongs to cenosis-dominant species. The basis of its adaptive capacities in cenosis is its ability to infinite and intensive growth.

The plants are characterized by intensive linear growth and ramification, and their fertility is caused by well-developed remontant ability. These features have been provided by a complex of biological and morphological peculiar properties. That properties act as a single protective and adaptive mechanism.

Some features create initial conditions for intensive growth, while others are its consequences.

The first type of features include ramification, unrestricted branching type, heterosis, large leaves, high absorptive capacity of root system, photosynthesis and transpiration intensity, which maintain its activity for a long time.

The special role in this complex is played by character of assimilates redistribution: under unfavorable (stressful) conditions buckwheat plants react by assimilate redistribution from generative organs to vegetative.

Assimilates play role of principal energetic reserve, which provides growth potencies of species (populations) in stressful situation. This causes low level and instability of buckwheat productivity.

Thus, it is necessary to create ecological ideotype (ecoideitype) with alleles of adaptive genome, which provide the most efficient ratio between vegetative and generative parts of plant with assimilates rational redistribution in favour of seed inception and formation - high and stable yield even in stress environmental conditions.

Materials and methods.

In buckwheat breeding process methods of index breeding - genetic selection by index features of architectonic of plant organs, by elements of productivity structure and by level of adaptability for unfavorable environmental factors - are used.

Also, methods of breeding for heterosis for forming of variaties-synthetics with multiple use of heterosis effect and simple hybrids with inbred lines of different depth are used.

Material has been bred by methods of genetic recombigenesis-hybridization. backcrosses and convergent crosses, different methods of inbreeding and genetic selection by elements of productivity structure, by duration of vegetation period, seed quality and indices of plant architectonic, with the purpose of buckwheat polymorphism expansion on features of morfological plants architectonics, plant productivity and adaptability.

Hybrids were bred in special nursery for hybridization with use of polycross test.

Confidentiality of obtained results was calculated by common statistical methods.

Results and discussion.

In the National Scientific Centre "Institute of Agriculture of the National Academy of Agricultural Sciences of Ukraine" carries on research aimed at creation of ecoideotype with rational architectonics. Also characteristics of variability and inheritance of economically

valuable buckwheat featurs, which are the most responsible for yield, character of action and interaction of genes responsible for these features and genetic effects of drifting of target feature are studied in the Institute.

In addition to investigation of direct quantitative characteristics, determining vegetative and generative development (plant height, ramification, internodes number, inflorescences number, kernel number and seed weight), which are considerably modified by environment our research directed at indices that cause predominantly integral features (yield and seed quality) and less depend on environmental conditions; in other words, investigate gene pool reconstruction aimed at its increased adaptability [11].

To such characteristics we attributed indices of elementary inflorescence grain content grain yield and attraction indices of buckwheat genotypes that minimally depend on environmental conditions (C_v = 0.21- 0.26).

These features have two advantages over their starting indices: lesser variability and considerable inheritance level. Using indices demands change of approach to morphophisiological genome structure: improving its architectonics for effective mobilization of photo synthetic processes, absorption capacity of photosynthesis products and their subsequent transition to generative organs (as a finalization of yield formation).

Analyzing the data on genetics of these features, which associated with buckwheat grain productivity and, finally - crop capacity, we received evidence of their polygenetic nature and high inheritance level (H^2= 0.82-0.85) with high additive variance index (h^2=0.25-0.38). This fact allows to predict buckwheat breeding prospects intended for yield increase through direct selection by the mentioned features [13, 6, 3].

The polygenetic nature of control of the mentioned features and their interstitial inheritance character allows full or partial retention in long-term sequence of genetic “shifts”, achieved during breeding process.

Discovered biotypes with high development of these features, in our view, present recombinations providing for protective-adaptive gene pool characteristics caused by evolution with active human participation.

Thorough investigation of buckwheat species’ genetics, particularly genetic nature of features that provide realization of crop potential for target features, is the fundamental for buckwheat breeding. On this basis, we improved those methods of buckwheat breeding, which help us

to breed a new generation of varieties bred for target features.

Their efficiency and application in breeding programs was confirmed by creation and implementation in economy a new generation of varieties with high patentability and competitiveness such as Lilea, Lyubava, Ukrainka, Antaria and Oranta, which provide advantage on existing features about 18-32% at high ecological plasticity.

Along with this, we continue our research for application of heterosis effect, basing on evolution of species and strategy of application of the most effective modern breeding methods for cross-pollinated crops.

In the National Scientific Centre "Institute of Agriculture of the National Academy of Agricultural Sciences of Ukraine" we use buckwheat heterosis effect in such fields as multiple heterosis application in sequence of generations through creation of synthetic varieties and single use of heterosis in breeding of inter-variety and interlinear hybrids.

Using as an example breeding of polysynthetic varieties of buckwheat such as Kyivska (1976), syn-3/02 (2010) we demonstrated its application efficiency for modificational poly-cross method in buckwheat breeding for heterosis with assessment of general combining ability of the best genotypes and their uniting into synthetic varieties.

However, the greatest success in breeding with heterosis for cross-pollinated species is conditioned by equalized homozygous lines use. The need in homozygotation of crossing components is caused by the fact that buckwheat, as other cross-pollinated crops during multiple re-sowing might change its heterozygous population's characteristics. This leads to their combinative property loss. Apart from that, high homozygotation causes high hybrids homogeneity.

The implementation of buckwheat breeding program with heterosis in this direction is impeded by absence of selected homozygous lines with high combination capacity, lack of scientific knowledge on inbred lines capacity for isolated proliferation, their inbred depression degree, as well as their cross-breeding level. In buckwheat, as in species with sporophytic incompatibility control, homozygotes appear only with ss gene recessive alleles. This is because they could be received only through forced self-pollination and saturating crossing.

By the cross-pollinating capacity the population structure depended on climate conditions and genotype, inbreeding depth, flower, structure. It manifested itself as 3.03- 14.3%; self-incompatible - 3.37-16.6%; partially self-incompatible plants - 70-87%, and self-compatible - 3.0-6.0% [9, 7].

We also discovered that with inbreeding intensification the percentage of self-compatible plants decreased to 2.5%, and the percentage of self-sterile genotypes increased up to 60%.

Such alterations character in buckwheat population was caused by homozygotation mechanisms by recessive alleles of self-incompatibility gene (s+).

The obtained information about characteristics of self-compatibility manifestations depending on genotype, environmental factors, flower structure and inbreeding depth allowed us to determine the ways of creation of autogamous homozygous lines and the need of studies of their possible application in practical breeding. It was revealed that cross-compatibility level for autogamous buckwheat progeny in case of its cross breeding was 13.7 - 87.5%; and with autogenic progeny inclination to self-fertilization in inter-linear hybridization the true hybrids share was 38.7 - 77.2%. At the same time inbred lines demonstrated heterogeneity by general combination capacity [3].

Development of new highly-productive varieties with constant yield demands principally new initial material, capable to stabilize the new high yielders. This means that new gene pool should bear features of drought-, heat-, cold-resistance and self-fertility, peculiar only to for some wild species. Their application as desired features donors in buckwheat selection is of high importance.

We worked together with researchers from the Institute of Molecular Biology and the Institute of Plant Physiology and Genetics of the Academy of Sciences of Ukraine on removing of such incompatibility barriers.

As the result we registered genetically caused closeness of cultivated buckwheat and some wild buckwheat species by karyological, immunochemical and electrophoresis characteristics. On this basis we developed distant hybridization method (L.K.Taranenko et al., 1998).

In order to overcome interspecies incompatibility we used growth-regulating physiologically active substances. The most effective of them were kinetin and cadmium salts. Embryo-culture application increased survival and germination of embryos of interspecies hybrids.

Using this material we obtained new initial material - short and dwarf forms with erectoid branches and leaves position, and with various types of inflorescences, productivity levels and fertility. Their true hybrid nature was confirmed by biological difference between interspecies interbreeding posterity, and by morphological and cyto-embryological examinations. The valuable initial material is used in

further breeding programs for creation of new highly-productive buckwheat varieties with increased resistance against stressful environmental factors.

The research that used index selection, heterosis effect, improvement of methods of principally new initial material creation, including those by introgression of valuable features of wild buckwheat species F.esculentum Moench opened possibilities for creation of new generation of highly-productive buckwheat varieties with constant yield.

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Базуючись на еволюційно-генетичних характеристиках виду Fagopyrum esculentum Moench, селекційна стратегія для нього забезпечує застосування індексної селекції, ефекту гетерозису: багаторазове використання в родоводі —для створення синтетичного сорту, та одноразове використання - для створення сорто- та міжлінійних гібридів.

Інтрогресія цінних властивостей диких видів в культурну гречку (Fagopyrum esculentum Moench) дозволяє створення фундаментально нового вихідного матеріалу для селекції гречки на адаптивність та продуктивність.

***Ключові слова:** селекція, сорти, інбридинг, гетерозис, індексні показники*

Basing on evolutional-genetic characteristics of species Fagopirum esculentum Moench, its breeding strategy provides with application of index selection, heterosis effect in the implementation fields: single-use in the lineage - for creation of synthetic variety, and single use - for creation of variety- and interlinear hybrids.

The introgression of valuable features of wild species to cultural Fagopirum esculentum Moench provides for creation of fundamentally new starting material for buckwheat selection by adaptability and productivity.

***Key words:** breeding, varieties, inbreeding, heterosis, target feature.*

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