

Research paper

Formation of buckwheat genepool collection in Ukraine and directions of its usage

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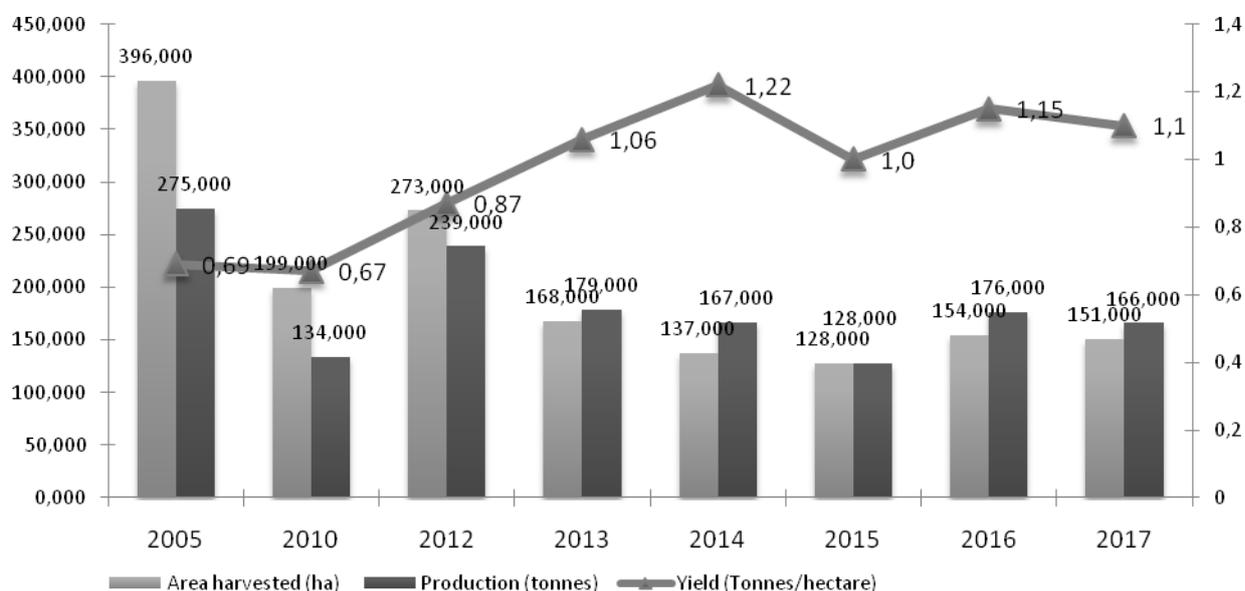
ABSTRACT

The national collection of buckwheat in Ukraine consists of more than 2,000 samples. The material is studied, reproduced and preserved in special storage facilities with controlled environmental conditions and temperature, humidity of grain in the hermetic containers. The research work, conducted over the genepool, has allowed separating the source of valuable for selection traits: high yield and productivity, large grain, low-growing plant, high seedling vigor, resistance towards abscission and impact of abiotic and biotic environmental factors. As a result of the fulfilling research program "Plant genetic resources" following actions are conducted annually: allocation of 10-15 sources of selection and agronomic traits of plant productivity, grain quality, adaptability of the material, etc .; software research and breeding facilities standards, sources and donors of valuable traits for breeding and other research - about 100 collection samples; transmission of 1-2 educational collections (30-50 samples) to educational institutions.

INTRODUCTION

Ukraine is one of the TOP 5 producers of buckwheat in the world. Anually 150,000 sq. hectares are used to grow buckwheat, and its yield is about 1.2-1.5 tons per hectare (Fig.1) (Maslak, 2017). Only one species - buckwheat common *Fagopyrum esculentum* Moench - is grown industrially. Environmental and climatic conditions on most territory of Ukraine are very favorable for buckwheat cultivation (summer

temperatures, humidity during spring and summer periods). In order to gain the highest yield possible, the main factor is the cultivation of varieties with highest production capabilities (Alekseeva et al., 2005). 26 varieties of buckwheat have been added into the State register of plant varieties suitable for dissemination in Ukraine in 2018, and only 2 of them were originating from abroad (Russian Federation) (State register, 2018).



The potential yield level of modern Ukrainian varieties ranges within 3.5 – 4.2 tons per hectare. Currently this level is implemented for 30-40% of the potential in field conditions. This situation is mainly caused by the sensitivity of buckwheat plants to environmental conditions and non-compliance with cultivation technologies etc. (Alekseeva et al., 2005). Current production volume covers 90-95 % of the national needs for buckwheat grain. Yet it is very obvious that under the appropriate

conditions Ukraine can become an exporter of this product. Quality of Ukrainian buckwheat grain and functional buckwheat products fully complies with all world standards.

In 2017 International association of research institutions, producers, processors and functional buckwheat products was founded in Ukraine. The main purpose of this Institution is the coordination of the activities of its participants and assistance in resolving questions related to research activities, grain production, growing,

processing and producing groats and other functional buckwheat products. The Association's task is to unite the producers of buckwheat products, strengthen the cooperation between producers and selection institutions, develop modern technologies, including the organic ones. The Association founders are the leading state and private research institutions, processors with significant production volumes.

It is necessary to resolve a number of factors to increase the production volumes, such as:

- Yield level stabilization;
- Reduction of dependencies on environmental factors (temperature fluctuations during inflorescence period and yield formation);
- Decrease of plant sensitivity towards soil humidity level.

Selection allows resolving these issues by using ecologically diverse initial material. This material can be obtained from plant genetic resources collections.

Description of National buckwheat collection of Ukraine

The National buckwheat collection of Ukraine is located in 2 institutions (Tryhub, 2015):

- Research Institute cereals them. Olena Alekseeva Podolsky State Agricultural and Technical University;

- Ustymivska experimental station of Plant Production of Plant Production Institute nd. a. V. Ya. Yuryev of NAAS.

The total volume of the collections located in these institutions is over 2000 authentic samples.

Scientific-Research Institute of Groat Crops nd. a. O. Alekseeva is located in western Forest-steppe area of Ukraine. The genepool of the institute has all categories of plant genetic resources belonging to 13 species of *Fagopyrum*: local populations, hybrid populations, selection varieties of common and intensive types, wild species, botanic forms,

polyploids, genetic markers and mutants. The collection formation took place in 1950-1971. The first samples were from western region of Ukraine. Over 500 samples in total were collected (Alekseeva, 1967). These samples had diverse morphological traits and different technological quality and biochemical content of grain. Starting from 1960 the experimental mutagenesis usage has started for selection purposes. A large number of original forms have been created: with significant branching capabilities, dwarfs, short-stem, green flower, with salad and anthocyan coloring of plant, different forms of inflorescences, large size of grain etc. Thanks to the significant input of academic Olena Alekseeva and her successors the basic collection of the institute has increased to over 1600 samples collected from all over the territory of former Soviet Union and 14 other countries (Alekseeva et al., 2005b). 115

collection samples are *Fagopyrum tataricum* Gaertn. (Nikitchuk, 2001). The collection of this institute is the short-term storage collection. A few years ago the institute has reinstated its active research work and started gathering and reinstating the collection; studying the industrial and biologic traits of both common and tartary buckwheat, cultivation technologies and selection of new varieties (Alekseeva et al., 2002).

Ustymivska Experimental Station of Plant Production is located in the central part of Ukrainian Forest-steppe territory with extremely favorable environmental conditions for buckwheat cultivation, soil quality and human expertise availability. The work with the collection in the Experimental Station started in 1954. The prolific weather conditions, huge diversity of genetic material of this region, significant planting acreage and stable grain yield volumes were the main factors of collection formation here (Tryhub, 2016). The collection formation supervisors were scientists from All-Union institute of plant production (Leningrad) – Krotov A. and Avezdzhnov R.

Nowadays the collection of Experimental Station consists of 1629 samples, 991 of which originate from Ukraine. The collection contains 6 samples of *Fagopyrum tataricum* Gaertn. and one - *Fagopyrum giganteum* Krotov. 23 samples are tetraploid. The collection has a wide diversity of varieties and species that allow in full and in a short time to assess the gene pool of buckwheat on a range of agronomic traits of adaptability to abiotic and biotic factors. Collection has a broad

representation of global diversity and contains materials from 23 countries of the world. This includes 20 regions of Ukraine, 28 - the Russian Federation and 5 - the Republic of Belarus. The collection contains buckwheat samples gathered during the expeditions performed by Vavilov N. during the mid-20th of the XX century.

As a result of years long research in the Ustymivska Experimental Station Krotov A. and Dranenko E., created a new species - *Fagopyrum giganteum* Krotov.



Fig. 2. *Fagopyrum giganteum* Krotov

The introduction of new material, its studying, reproduction and preservation is conducted during the work with the collection.

As a result of the fulfilling research program "Plant genetic resources" following actions are conducted annually:

- the introduction of new valuable varieties into the gene bank of Ukraine in the amount of 5-10 samples;

- the gene pool study based on economically valuable indicators (cold-, drought- and heat resistance, diseases- and pests-resistance and the productivity of its elements, the quality of the crop, etc.) - more than 100 samples;

- allocation of 10-15 sources of selection and agronomic traits of plant productivity, grain quality, adaptability of the material, etc.;

- cultivation and transfer to storage in the storage doublet repository of Research Station (about 200 samples - to collection and 100 samples - to storage in a National repository of Ukraine);

- software research and breeding facilities standards, sources and donors of valuable traits for breeding and other research - about 100 collection samples;

- transmission of 1-2 educational collections (30-50 samples) to educational institutions;

- the formation and transmission of the attributive and special collections for the registration to the National Center GRPU;

- unique samples of collection of the gene pool are sent to the registration;

- supplying with the information on the gene pool of plant breeding and research

institutions of Ukraine and other countries (publication of 2-3 articles).

The storage of seed collection is conducted in the special repository that was provided in the mid-1990th as part of the cooperation with IPGRI. The controlled temperature (+2–+4°C) and humidity of environment (not more than 30%) are kept in the storage. Seed is stored for preservation with humidity of 6-7%.

All collections samples are entered into passport database, information about most of them is available in the Internet.

In the National Center PGRU seven buckwheat gene pool collections are registered by the station: base collection; educational collection of buckwheat gene pool; four indicative collections of buckwheat gene pool by yield and largest grain, productivity and drought resistance and heat resistance, adaptation to mechanized cultivation and productivity of the material and core collection.

In addition to the mandatory set of traits to determine the yield characteristics of the collection material, research has been done to determine:

- plant resistance to shattering and breakage of the stem (as lodging resistance characteristics) using special devices;

- drought resistance in growing material under controlled conditions (special containers and other), as well as the study of physiological parameters (water shortages, water-holding capacity, changes in germination of seeds after heating, etc.);

– heat resistance by using special methods;

– flower size in different samples and species; protein and starch contents in the grain, etc.

In addition, the most early-maturing samples (60-70 days) were cultivated, with stem fasciation, determinant type of growth, two or three carpal and long lateral inflorescences, two leaves at the node near the inflorescence, with lateral inflorescences in the form of branches, with narrow leaflets, high attachment of the lower inflorescence (more than 30 cm), with a small number of nodes on the main stem (6 pcs.); pest-resistant; low intensity of transpiration and water shortages, high water-holding capacity.

The method of isolation with the help of tetraploid buckwheat is used for reproduction of diploid samples. The distance between diploid samples is 8 – 10 m.

Annually in order to fulfill the requests made by different institutions and on the own initiative, consumers are being given more than 100 unique samples. Over the past 10 years, we sent more than 500 samples after examination and evaluation to the main selection institutions.

Based on the latest tendencies of buckwheat usage directions expansion we have started researching in the new vectors: selection of the forms which could be used as green manure fertilizer, studying antioxidant traits of common buckwheat from different ecologic and geographic origin.

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