Importance of starting material for plant breeding

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Abstract. All agricultural crops are created by breeding. But the use of breeding is closely related to the methods of obtaining the source material. As these methods improved, new possibilities for breeding opened up and its creative role in the creation of new plant breeds increased. It is very important to know what all or a certain group of breeds have in common and how they differ from each other. It is important to emphasize the following points - the group of plants that make up the variety has a common origin. It is a multiplied offspring from one or a few plants. By propagating the parental initial plants, in their offspring, through breeding, they achieve similarities in economic and biological properties and morphological characteristics. The degree of this similarity, depending on the source material and breeding methods, may be different. The variety is created for cultivation in certain natural and production conditions. In the presence of appropriate natural and production conditions, the variety should provide stable high yields and quality products.

1 Introduction

The Doctrine of Food Security of the Russian Federation for the period up to 2030, adopted to replace the document of 2010, indicates the indicators of self-sufficiency of the population with agricultural products of domestic origin, raw materials and food. The threshold values for some types of products have already been reached, but judging by the results of the analysis still have a lot to build up and keep at a competitive level. Consumption of the population against the background of the development of unfavorable economic conditions within the country is falling, as the real incomes of the population are falling.

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2 Problem statement

The purpose of the study is to evaluate the source material as an important aspect of plant breeding.

3 Research questions

Currently, about 1800 thousand species of organisms are known, including more than 500 thousand plant species, of which 300 thousand species are angiosperms. To understand the wide variety of animals and plants, they are classified and systematized (Figure 1).

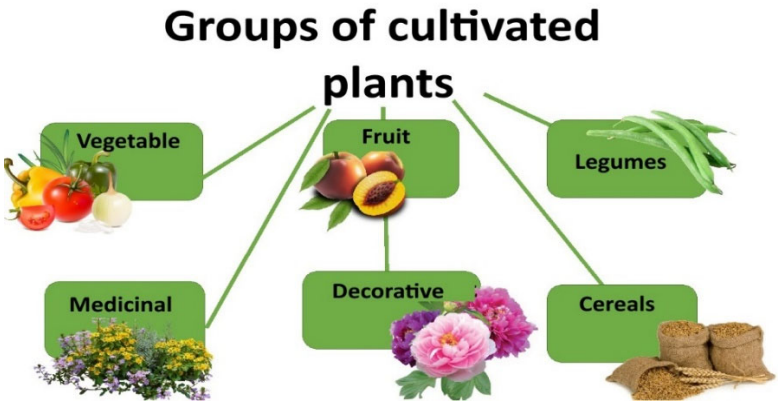

Fig. 1. Groups of cultivated plants.

The science that develops the principles of classification of the organic world is called systematics. This is the basis of knowledge of the animal and plant world. Its task is to build a natural system that reflects the process of evolution of living substances. Based on the common origin of organisms, they are combined into groups - systematic taxonomic units. The basic systematic unit is the species. A species is a set of individuals that are related in origin and have qualitative differences from other species and individuals of the same species are similar to each other, easily interbreed and give fertile offspring. They are adapted to life in certain conditions and, as a result, occupy a certain area [2].

4 Materials and methods

In the middle of the XVIII century the Swedish naturalist K. Linnaeus proposed a double, so-called binary nomenclature for designating species, based on the principle of combining related species into larger systematic groups - genera. Each plant in the binary nomenclature is designated by two Latin words. The first is the name of the genus, it is written with a capital letter, followed by the proper species name with a lowercase letter. For example, the soft wheat species in binary nomenclature ¬is designated Triticum aestivum, a kind of cultivated potato - Solanum tuberosum. The botanical classification of plants includes other systematic units. Close genera are combined into one family, species are divided into breeds. When studying and using the source material in breeding, it is necessary to know the subordination of the following basic systematic units: family - genus - species - variety. Families are presented as the highest systematic units that have to be dealt with in practical breeding work. In the general botanical classification, families are included in orders, orders in classes, classes in types, etc. The higher the level of classification, the sharper the differences between

its constituent units. As the lower units, the scheme shows breeds, the differences between which are much less than between species. So, the type of wheat is divided into breeds only by differences in the colour of the ear, the presence or absence of awns, their color, pubescence of the spikelet scales and the colour of the grain. Breeds in botanical taxonomy are divided into forms. But for the systematization of forms within breeds there are no definite distinctions, and therefore they are not given in the scheme. Botanical systematics is only the first step in understanding the diversity of cultivated plants. Such knowledge is absolutely not enough for practical breeding. It is necessary to know not only the species and breeds of a given culture, but also their biological characteristics, which are associated with the adaptation of plants to various growing conditions [7,8]. Plants belonging to the same botanical variety but of different geographic origins can differ dramatically in resistance to drought, low temperatures, disease and pest damage, and also have biochemical differences. Plants of the two forms may belong to different breeds, but be characterized by similar biological features. Since there are biological differences between plant forms within the same species, the concept of ecological type, or ecotype (from the Greek eikos - house) is very important in breeding. This is a relatively hereditarily stable form of this species, adapted to existence in certain soil and climatic conditions. For example, the northern and southern forms of the awnless brome are two separate ecotypes of this species; they differ significantly in biological characteristics. The science that studies the relationship between plants and the environment, the patterns of formation of ecotypes, is called ecology. For various plant species, ecology has established three important common ecotypes: xerophyte, hygrophyte, and mesophyte.

5 Results

Plants adapted to arid conditions of existence are called xerophilic, plants adapted to life in excessively humid habitats are called hygrophilic, and plants adapted to grow in conditions of medium (sufficient) moisture are called mesophilic. For breeding, it is necessary to have a characteristic of the same and different in terms of economic and biological characteristics of plant forms when grown in different soil and climatic conditions.

In this case, the following indicators are most important:

1. differences in the duration of the growing season and its structure, i.e. in the passage of individual phases of development;
2. quantitative characteristics that determine the yield (number and weight of seeds, fruits, etc.) and its structure;
3. vegetative characteristics (stem length, foliage, degree of regrowth after various injuries, etc.);
4. features of flowering (open, closed, change in the type of flowering at different temperatures and moisture);
5. the degree of resistance: to various forms of drought (soil, atmospheric, combined, spring and summer), to the action of low temperatures (for winter plants - differences in winter hardiness), to various types of diseases, taking into account the racial composition of parasites, to damage by agricultural pests, to lodging, shedding and other signs that determine suitability for mechanized harvesting;
6. differences in the biochemical composition of the crop (variability in the content of protein, sugar, starch, fat, etc.);
7. relation to moistening conditions (xerophilic, hygrophilic or mesophilic types of development).

The characteristics of plant forms, the degree of their similarity and difference in these and many other biological features are given as a result of their ecological and geographical grouping. Ecological and geographical systematics of cultivated plants, the founder of which

is Academician N.I. Vavilov, reflects certain patterns in the differentiation of species into ecological and geographical groups [9].

Each such group is characterized by features similar to all cultures, formed under the influence of breeding in the same natural and geographical conditions, and the differences between plants of different groups are significant both in morphological characters and in physiological properties. In Russia an ecological and geographical study of many cultures has been carried out, the main ecotypes that have developed under various habitat and cultivation conditions have been identified and described.

For example, according to the Institute of Plant Industry the following main ecological groups have been established for wheat: steppe, forest-steppe, forest, Western European, northern early, Central Asian, mountainous Tajik, foothill, Azerbaijani. The study of cultivated plants on the basis of ecological and geographical principles made it possible to elucidate the role of natural and artificial breeding and the significance of external conditions in the formation of various ecotypes. In full accordance with the teachings of Darwin, ecological and geographical systematics establishes that the evolution of cultivated plants in time and in various geographical conditions is associated with human activities in the breeding and cultivation of plants. According to the scheme proposed by N.I. Vavilov, the species are divided into various ecological and geographical types, which, in their turn, are divided into botanical breeds, and botanical breeds are divided into forms and varieties. Consequently, the study of the source material in plant breeding must be carried out on the basis of botanical as well as ecological and geographical systematics [10].

As a result of the constant variability of plants, morphological, physiological and biochemical differences are created between them, which are used and enhanced in the breeding process when creating new breeds. Breeds qualitatively, i.e. in essential features, differ from each other in their characteristics and properties. Any form or variety of plants is characterized by a combination of many features and properties.

Signs are called morphological features and structural features of the plant. These include:

- plant height, number and size of leaves, stem thickness, number of internodes and tillering shoots (in cereals);
- the size of the ear, panicle, cob, tuber, root crop, fruit, grain size;
- the presence or absence of awns and pubescence, the density of the ear or panicle (in cereals);
- coloring of seeds and fruits, etc.

The economic significance of various traits is not the same, and one is of greater importance, while others are of lesser importance.

Plant traits are conventionally divided into two groups:

1. high-quality, easily determined visually (color, shape, presence or absence of awns, pubescence);
2. quantitative, determined by measuring, weighing and counting (the number of grains in the ear and cob, the mass of tubers and roots, seed size, stem length and thickness).

Any qualitative sign can be given a quantitative characteristic, but in most cases this is not done, since sufficient certainty in the assessment is achieved by eye. Often eye observations are quite enough to establish quantitative signs. So, when evaluating some breeds by stem height, they are limited by the characteristic: high, medium, low. Determining the size of the grain, they often evaluate it as large, medium, small, etc.

6 Findings

Physiological, biochemical and technological features of plants are called properties.

The main indicator of the value of a variety is its yield. Productivity is a complex combination of many economic and biological characteristics and properties of a plant. Any trait or property of an organism in each generation develops anew on the basis of one or more genes when they interact with external conditions [11,12]. Since the external conditions in which an organism develops are never constant, the same trait is expressed in different quantities, and the qualitative traits are more tightly controlled by genes and are more stable.

All cultivated plants, as well as their wild relatives, are represented by a wide variety of breeds and forms, differing in many characteristics and economic and biological properties. This is an important prerequisite for the success of breeding work.

Breeding work begins with the breeding of source material, which can be used as cultivated and wild forms of plants (Tables 1-3).

Table 1. Five major genebanks in the world (FAO, 2009).

Country	Number of samples
USA	508 994
China	391 919
India	366 333
Russia (VIR)	322 238
Japan	243 463
Source: Information from the official FAO website.	

Table 2. Genetic collections of the CIS countries.

Country	Number of samples
Russia (VIR)	324 000 (54,1%)
Ukraine	130 000 (21,7%)
Uzbekistan	55 000 (9,2%)
Kazakhstan	35 000 (5,8%)
Belarus	32 000 (5,3%)
Georgia	7000 (1,1%)
Armenia	5000 (0,9%)
Moldova	5000 (0,9%)
Kyrgyzstan	3000 (0,5%)
Tajikistan	3000 (0,5%)
Total	598 000
Source: Information from the official FAO website.	

Table 3. World collections of ten economically significant crops (FAO, 2009).

Culture	Number of samples
Wheat	857 940
Rice	773 847
Corn	327 931
Beans (beans)	262 369
Sorghum	235 711
Soya	229 947
Oats	148 260
Peanut	128 461
Potato	99 253
Peas	93 977
Source: Information from the official FAO website.	

7 Discussion

In modern breeding, the following main types and methods of obtaining source material are used.

I. Natural populations. This type of source material includes wild forms, local breeds of cultivated plants, populations and accessions presented in the Institute of Plant Industry world collection of agricultural plants.

II. Hybrid Populations:

1) intraspecific, created as a result of crossing of breeds and forms within the same species;
2) populations obtained as a result of crossing of different species and genera of plants (interspecific and intergeneric).

III. Self-pollinated lines (incubation lines). In cross-pollinating plants, an important source of starting material is self-pollinated lines, or inbred lines obtained by repeated forced self-pollination. The best lines are crossed with each other or with breeds , and the resulting seeds are used for one year to grow heterotic hybrids . Hybrids created on the basis of self-pollinated lines, unlike conventional hybrid breeds, need to be reproduced annually.

IV. Artificial mutations and polyploid forms. This kind of source material is created by exposing plants to various types of radiation, temperature, chemicals and other mutagenic agents. The significance of different types of source material in the development of breeding and at present is not the same.

At present, the state of mobilization of plant resources for the purpose of breeding is characterized by the efficiency of very large specialized centers (“gene banks”). Among them, an important place is occupied by the N.I. Vavilov (Institute of Plant Industry). Institute of Plant Industry scientists have done a great job of collecting, studying, preserving and distributing samples of cultivated and wild plant flora [1,2,3]. Today the collection includes about 325 thousand samples.

In terms of plant taxonomy, the work of Institute of Plant Industry also turned out to be productive and useful. Its’ expeditions discovered more than 200 new cultivated and wild potato species, more than half of the currently known wheat species, and this is 12 times more

breeds of wheat than previously known. Herbarium material of cultivated plants from all over the world and their wild relatives (including weeds) of the Institute of Plant Industry named after N.I. Vavilov includes more than 674,500 sheets.

It is necessary to pay attention to some of the main rather large and well-known centers of international level, in which the genetic characteristics of plants are studied. Here it is worth pointing out such centers as, for example, IRRI, CIAT, International Maize and Wheat Improvement Center, ICARDA, ILKA. In total, the global plant gene pool is located in 1750 genebanks, which preserve 7.03 million samples of different crops. 130 of them have collections exceeding 10,000 samples.

It shall be clarified that the world's crop gene pool is contained in about two thousand different banks that store samples of various plants. There are special collections, of which there are about one hundred and thirty thousand, and they contain about ten thousand different examples of plant resources [4,5].

8 Conclusion

It shall be noted that it is in itself a genetic source. First of all, this is a special sample, which is distinguished by important properties and characteristics. It is important that they are able to be inherited. The donor, in turn, is considered the main source, which is studied for useful properties. It is clear that these parameters are under control. They are simply passed on to their descendants, and this is their main advantage. During detailed analysis, genes are described. There is a point of view that a special plant variety called Jet. It is distinguished by special genes associated with resistance to certain dangerous diseases. But there is a risk of a low yield. There is a specific gene of a certain variety that is devoid of problems. In addition, there is a donor of such an indicator as a short stalk in wheat. The focus is on a particular variety called Noreen 10 (genes Rht 1 and Rht 2). There are two peculiar genes, they have a special protein. It is important to clarify the presence of a special mutate form of winter wheat, which is free from negative correlation indicators (Krasnodar dwarf 1 (genes Rht 8, Rht 11)), obtained from the famous variety Bezostaya 1. Gusarka (Bulgaria), Biserka (Serbia) breeds at the same time differ in this characteristic like precocity.

For the successful conduct of breeding and seed production and the correct use of breeds in agricultural production, it is necessary to have a good understanding of what a variety is. It is very important to know what all or a certain group of breeds have in common and how they differ from each other.

It is important to highlight the following points:

1. The group of plants that make up the variety has a common origin. It is the propagated offspring of one or a few plants;
2. By propagating the original parent plants, their offspring, through breeding, achieve similarities in economic and biological properties, and. morphological features. The degree of this similarity, depending on the source material and breeding methods, may be different.
3. the variety is created for cultivation in certain natural and production conditions. In the presence of appropriate natural and production conditions, the variety shall provide stable high yields and high-quality products [6].

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