



## Balkan cereals genetic resources in collection of Vavilov Institute of Plant Industry and main directions of cereals breeding in Russia.\*

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### Abstract

Analysis of information about Balkan cereals collection in VIR passport database is presented. The paper offers the long-term data on the collection of cereal forage crops (barley, oat) studied under diverse conditions at experiment stations of VIR. The selected sources of economically important traits that can be used for main direction of cereal forages breeding are presented.

**Key words:** Balkan countries, wheat, barley, oat, rye, sources, donors, economically important traits, breeding.

### Introduction

Collections of the N.I.Vavilov All-Russian Research Institute of Plant Industry (VIR) number over 325 thousand accessions of plant genetic resources which include both a widest range of cultivated crops and their wild relatives. It is the oldest in the world and the largest in Europe genebank. Since its initiation in 1894 in the form of the Bureau for Applied Botany, VIR has been closely cooperating with all European countries. All accessions from the VIR collections have been studied under conditions of the Russian Federation for main direction of conventional breeding (Loskutov, 1999; 2009).

Collections of grain forage crops at the Vavilov Institute of Plant Industry serve as the main source providing new initial material to main directions breeding aimed at creating new cultivars. The long-term efforts exerted to collect the global diversity have resulted in gathering at the institute barley and oat collections that are among the largest in Europe. They number about 18000 accessions of barley and over 12000 oat accessions of different geographical origin (Loskutov, Rines, 2011).

Creation of new agricultural crop cultivars possessing a complex of important traits, high yielding ability and product quality under different environmental conditions requires the well-studied initial material. The problem of selecting the most promising parental forms for crossing from the available genetic diversity of crop plants still

remains one of the most difficult and responsible moments in the breeding process.

Cereal forage crop breeding is mainly aimed at raising cultivar grain productivity. Besides, duration of the vegetation period is an important trait that is directly linked with grain yield, its quality and seed sowing qualities. Therefore, in terms of productivity, the mid-early and mid-season cultivars of grain forage crops would be the best in terms of productivity. A potentially high grain yield of agricultural crops should be combined with other economically important traits and resistance to biotic and abiotic factors (Lukyanova et al., 1990; Rodionova et al., 1994). Diseases not only suppress plants and reduce the size of grains and yields per unit area, but also deteriorate the yield quality through the accumulation of pathogens waste products.

Mycotoxins decrease the cost and consumption properties of oat and barley grain and adversely influence human and animal health. The problem of creating cultivars resistant to main diseases becomes of primary importance, since it is the safest way of disease control. Only the availability of adequate initial material will make it possible to successfully solve these and the newly arising problems in breeding. Identification of sources of the main economically important traits is one of the tasks of studying the global diversity of barley and oat accumulated in collections of the Department of Oat, Rye and Barley Genetic Resources at the N.I. Vavilov All-Russian Research

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Institute of Plant Industry (VIR) (Loskutov, 2007; Loskutov et al., 2007).

### Material and Methods

For Analysis of passport database of VIR Balkan countries collections of wheat, barley, oat and rye we used opportunity of computer program Corel Paradox 9 and Microsoft Excel 2010.

The barley and oat collections of VIR are studied in field conditions at experiment stations of the Institute, most of which are located in the main zones of agricultural crops cultivation (Loskutov, Kovaleva, 2007). For study of the cereals crops collections we are used VIR guidances (Lukyanova et al., 1973; Loskutov et al., 2012).

The Department of Oat, Rye and Barley Genetic Resources of VIR widely applies the methods of the initial material joint study to meet necessities of common and new trends in breeding that take shape due to the global climatic and phytopathological changes and due to new quality demands in grain processing for food and forage (Loskutov, 2014).

### Balkan cereals genetic resources

The first accessions collected on the territory of Balkan countries date from the beginning of 1920-s. The passport database of VIR collections is available online and offers data on

the most historically interesting crop accessions (Passport). For instance, collecting of genetic resources of wheat, rye, barley and oat was carried in the first half of the 20<sup>th</sup> century before WW2 in such Balkan countries as Turkey, Albania, Bulgaria, Greece and all countries from former Yugoslavia (Table 1). Passport data on each accession contain information about the entity that collected the accession or handed it over to VIR and the time frame (Figure 1). This material is represented by landraces, primitive varieties and improved cultivars collected or created in the first half of the 20<sup>th</sup> century. All accessions of the above-mentioned crops display wide botanical and genetic diversity that covers a big number of forms possessing special importance for breeding purposes. Thereby this region is characterized as primary and secondary centers of origin and diversity of small cereal crops. Besides, the collections include breeding material from the mentioned countries (most of all from Bulgaria and Serbia, etc.) that was collected or otherwise included in the collections in the 1960's–80's. These accessions are represented by improved cultivars and breeding lines that feature a wide diversity of economically important traits.

**Table 1.** Landraces and breeding cultivars of Balkan origin in VIR collection

	<b>Wheat</b> 1902-2010	<b>Barley</b> 1904-2002	<b>Oat</b> 1921-2008	<b>Rye</b> 1925-2009	<b>Total</b> 1902-2010
<b>Albania</b>	60/5	2/2	6/2	1/0	69/9
<b>Bulgaria</b>	235/721	17/291	138/132	100/31	490/1 175
<b>Greece</b>	152/106	12/52	49/26	0/2	213/186
<b>Romania</b>	19/645	44/164	40/14	0/29	103/852
<b>Turkey</b>	1 407/747	370/431	199/176	66/66	2 042/1 420
<b>Ex Yugoslavia*</b>	417/978	115/350	190/113	102/6	824/556
<b>TOTAL</b>	<b>2 290/3 202</b>	<b>560/1 290</b>	<b>622/463</b>	<b>269/134</b>	<b>3 741/5 089</b>
<b>VIR collection</b>	<b>37 955</b>	<b>18 007</b>	<b>10 588</b>	<b>3 212</b>	<b>69 762</b>

\* Ex Yugoslavia – Serbia, Bosnia & Herzegovina, Croatia, Slovenia, Montenegro

Above – landraces, below – breeding material and cultivars

### Agronomical traits

The most important factors influencing duration of the vegetation period of a plant, especially its first part, are the light day duration and temperature regime. The results of long-term studies performed together with the Department of Plant Physiology of VIR have discovered a variety of responses to photoperiod and vernalization. Among the recently identified barley and oat accessions with insensitive to photoperiod were forms from Russia, Turkey, Canada, Mexico, Brazil,

Columbia, Australia (Koshkin et al., 2010, Loskutov, 2007, Loskutov et al., 2007).

The problem of dwarfness is closely linked to the problem of lodging resistance in cereals, it occupying a special place among the breeding objectives for these crops. Investigations of the oat genetic collection performed in recent years have identified accessions that combine semi-dwarf with a high grain productivity of the panicle and good grain quality (from USA, Canada, Australia), and can be recommended for the use in breeding

(Loskutov, 2007, Loskutov et al., 2007; Loskutov, 2014).

Plant productivity is composed of several elements, namely the number of spikelets and grain per spike or panicle, grain mass per ear or panicle, grain mass per plant, and 1000-grain weight (from Russia, Germany, Czech Republic, USA, Canada). Selected cultivars have been found to have high ear or panicle productivity. The accessions identified for their high 1000-grain weight showed a value over 50 g (Loskutov, Kovaleva, 2011).

The main character grain weight per area unit is a complex index of productivity that significantly varies depending on the growing conditions and cultivar peculiarities.

### Disease resistance

A complex phytopathological evaluation of all the specific diversity of *Avena* facilitated identification of new sources and donors of resistance that can be used for broadening genetic basis of the newly created oat and barley cultivars. A strong natural infectious background allows evaluating resistance of accessions to diseases in field conditions. Crown rust affects oat crops each year during the ear formation–ripening stage (from Russia, USA, Canada, Uruguay). The screening in the field has identified a set of barley accessions that displayed resistance under a strong infectious stress. A study of the barley collection resulted in the identification of a series of sources of complex resistance to loose and covered smuts (from Russia, Kazakhstan, China, Ethiopia). Helminthosporium blight is known to annually affect oat and barley crops to a varying degree (from Russia, Turkey, Ethiopia, USA). Barley yellow dwarf virus (BYDV) is a very harmful disease that can lead to the total death of plants. It was selected tolerant accessions from UK, USA, Canada (Loskutov, 2007; Loskutov, Kovaleva, 2007; Loskutov et al., 2007; Loskutov, Kovaleva, 2011)

Together with the All-Russian Institute of Plant Protection (VIZR, Russia) and American colleagues from the University of Minnesota (U of M, USA), sources of resistance to the most harmful strain of stem rust (Ug99) have been selected from commercialized Russian barley cultivars (Loskutov, Kovaleva, 2011).

Joint investigations of spring barley performed together with the American colleagues from the U of M (USA) and of oat performed together with VIZR (Russia) resulted in the identification of sources of grain resistance to *Fusarium* Head Blight and mycotoxins contamination in caryopses within both crops. It has been found that the highest degree of

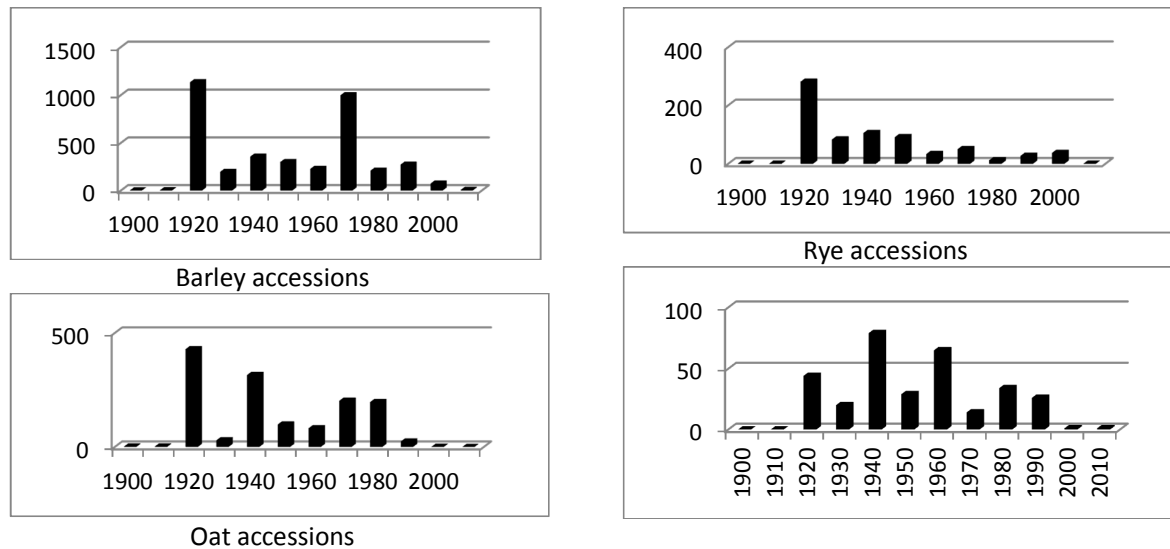
resistance is displayed by naked barleys and oats from China, however, single resistant accessions have also been identified among hulled barleys and oats from Russia, Japan, China. The most promising in terms of multicomponent resistance to FHB were found to be oat landraces originating from the Far East of Russia and Asia continent, resistance to *Fusarium* infection has been found in productive naked oat and barley cultivars (Dahl et al., 2009; GavriloVA et al., 2013).

### Quality components

Due attention is paid to the study of traditional biochemical parameters. A study of a set of barleys and oats performed together with the Department of Biochemistry and Molecular Biology of VIR has identified high-protein accessions from Uzbekistan, Iran, Afghanistan, USA, Canada and Ethiopia (Loskutov et al., 2014).

The most important biochemical components that increase nutritive value of oat include protein, fats,  $\beta$ -glucans, tocopherols, sterols and other components. At present, this trend in studies of the collection is the most promising one. A set of oat cultivars has been analyzed for oil content in the caryopsis and its fatty acid composition. This work was done together with the Department of Biochemistry and Molecular Biology of VIR. Some accessions had over 7% of oil in the caryopsis; these were some local naked oats from Russia, China, Mongolia, and Great Britain, and several hulled oat accessions from Russia, Mongolia, USA, Canada. Speaking about the fatty acids composition, it should be noted that almost all studied accessions had a level of oleic acid content as high as that in sunflower. It was above 40% in some accessions from China, Spain, Great Britain and Russia. Besides, a high content of palmitic, oleic and linoleic acids was demonstrated by cultivars of naked oat (Loskutov et al., 2007).

Some accessions of spring naked barley have been analyzed for  $\beta$ -glucans content. This work, performed together with the Baltika Brewery Company (St-Petersburg, Russia), has shown that two-row barleys had a content of said component that was on the average 1.5 times higher than in six-row barleys. Also, joint investigations with the Protein+ Company have resulted in the identification of sources of  $\beta$ -glucan, a non-starch polysaccharide, in oat accessions. Barley and oat with the above-mentioned high quality values can be effectively used in the production of combined feeds, as well as in the food industry, especially for dietary food manufacturing (Loskutov, Kovaleva, 2011).



**Figure 1.** Number of cereals accessions of Balkan origin in VIR collection collected in 1900-2010. Wheat accessions

## Conclusions

The global collection of Vavilov Institute of Plant Industry has been preserving rich diversity of landraces and obsolete cultivars from Balkan countries, which could be valuable sources for breeding in whole world.

The complex field evaluation combined with the analysis performed together with methodological laboratories of VIR makes it possible to select valuable genetic material required for solving burning problems of breeding in different regions.

To sum it up, collections of cereal forages at VIR serve as the main source of initial material required to meet the needs of the main directions in breeding of said crops. The identified barley and oat sources have been sent to over 25 breeding centers in the Russian Federation for breeding new productive cultivars of cereal forages.

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