ISSN 1313-2539

CEREAL BREEDING AT THE INSTITUTE OF AGRICULTURE "OBRAZTSOV CHIFLIK"- RUSE, BULGARIA: I. OAT SITUATION AND PERSPECTIVES

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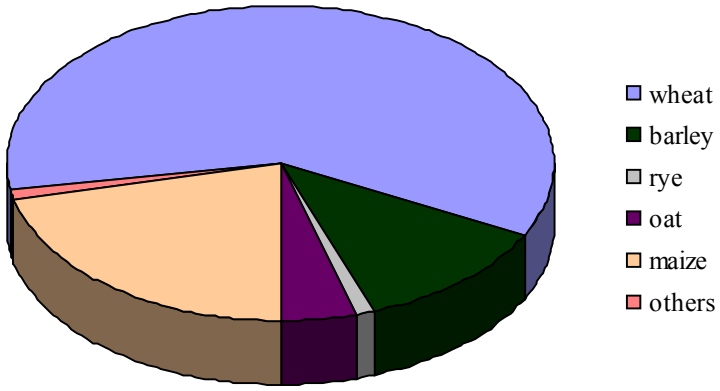
Abstract

Oat breeding program in Bulgaria is mainly carried out at the Institute of Agriculture and Seed Science "Obraztsov Chiflik"- Ruse. The program is focused on improving agronomically important traits in oat: yield potential, grain quality, tolerance to environmental and biotic stress and disease resistance, as well as milling, feed and hay end-use quality in both naked and hulled oat varieties. The aims of the breeding are the development of spring and winter oat varieties suitable for the environmental conditions of Bulgaria for growers, food processors and animal production systems.In view of the importance of oat germplasm for the success of the breeding the Institute has a large breeding collection included local varieties and populations, foreign varieties from the various public and private breeding programs, advanced test lines. Oat varieties development is carrying out through hybridization, advancing early generations in bulked and pedigree nurseries, followed by performance testing of selected lines. Thus, there is a need for the breeding of lines and varieties suitable for growing in many different environments throughout the country, climatic conditions in Obraztcov Chiflik are extreme with cold temperatures during the winter months and drought during the summer. The Institute of Agriculture and Seed Science "Obraztcov Chiflik" - Ruse develops and releases improved common and naked spring and winter oat varieties for the farmers and the food industry.

Key words: *cereal, oat, breeding, variety, quality, yield*

1. INTRODUCTION

Oat is one of small grains that have gained in importance in recent years, particularly with the availability of new varieties (Kirilov, 2004; Peltonen-Sainio, 1992) (figure 1). Oat is the fourth most important grain crop in Bulgaria. The oat acreage harvested for grain in 2006 is estimated to be 41 000 acres, down about 15% from 2005.

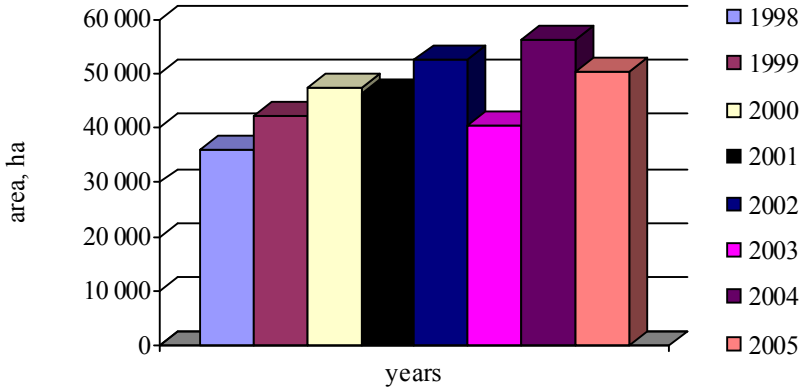


Fugure 1. Cultivated area of small grains, 2005, Bulgaria

ISSN 1313-2539

(Source: Agro statistic – BANSIK-86/2005, Ministry of Agriculture and Forestry, Bulgaria)

The privatization of agriculture in recent years has brought an increase in consumer demands for oats with enhanced quality and broader adaptability and in widening of areas (figure 2).



Fugure 2. Cultivated area of oat in Bulgaria

(Source: Agro statistic – BANSIK-86/2005, Ministry of Agriculture and Forestry, Bulgaria)

Short variety strength of oat in the country does not meet the market demands of forage oat varieties as well as varieties for production of baby and dietetic foods. The emphasis of the breeding is to develop new varieties of spring and winter oat with different tendencies for using, well-adapted to the environmental conditions (Panayotova, 2002). Climatic conditions in Obraztsov chiflik, near the town of Ruse are extreme in relation to temperature during winter months and drought during summer. There are natural conditions and opportunities for selection of forms, suitable for growing throughout the country.

2. OBJECTIVES

Current breeding objectives include:

2.1 Developing improved varieties and germplasm for forage grain - high yielding, dwarf, resistant to freezing, disease resistance and high grain quality

2.2 Developing improved varieties and germplasm for green mass – long-stemmed, well leafy, high high content of protein in green mass, disease resistance, suitable for joint growing with winter beans

2.3 Developing improved spring varieties and germplasm for production of baby and dietetic foods - naked grain and grain with easily dividing hulls, combining high grain yield, disease resistance, high grain protein content and balanced amino acids profile, fibers, fats and end-use quality.

2.4 High-temperature, drought, and winter freeze stress tolerance

2.5 Value adding to improve the marketability of oats

ISSN 1313-2539

3. MATERIALS AND METHODS

Breeding has three major components:

- variability,
- selection and
- testing.

3.1 Variability

The importance of oat germplasm for the success of the breeding program and for the status of ecological conditions has become more greatly appreciated. The "Obraztsov chiflik" institute disposes with a large collection that includes local and foreign oat varieties and populations, test lines, samples obtained by the National Collection of the USA, Canada and Europe, including the European Collection of sources of stability to oat diseases. The gradual study of these collected materials has revealed their potential as initial breeding materials and genetic resources (Panayotova and Mincheva, 2003). Preliminary research on large part of the collection materials was made with a view of combining the most valuable traits of the best Bulgarian and foreign oat varieties. The genetic diversity contained within this collection acts as a valuable resource for the breeding. In order to get higher percentage of seeds, different hybridization methods and techniques of pollination were tested – mechanically and chemically. By using the mutagenesis method in applied independent and combined treatment with gamma rays (Co_{60}) (Panayotova, 1995), ethyl methane sulphonate /EMS/, sodium azide (SA) and the selection assessment of mutagenic generations, lines with improved agronomic characteristics of plant and grain were isolated and used as an initial material in the selection of some valuable qualities as: productivity, dwarfness and resistance to crown rust.

3.2 Selection

Approach:

3.2.1 Development of new cultivars

In conformity with the breeding tasks set, genetic studies on the inheritance of traits, connected with grain yield and quality through hybridization in diallel crossing schedule Method II, Model I (Griffing, 1956a; Griffing, 1956b) were made (Panayotova, 2005; Panayotova and Tsenov, 2005; Panayotova and Tsenov, 2006). The evaluation of parental materials and their progenies, made in the initial stages of breeding is considerably important for a proper strategy of subsequent selection (Machan, 1989). The most frequent genetic methods, enabling this evaluation are represented by analysis of general and specific combining abilities (Caierro et al., 2001; De Koeyer, et al., 1998; Doehlert, et al., 2001). The analysis of experimental results was done on the basis of following schema:

$$x_{IJK} = \mu + g_I + g_J + s_{IJ} + e_{IJK}$$

x_{IJK} - *value of a feature selected in the cross i x j in k - th replication*

μ - *average value of the total set of crosses*

g_I - *general combining ability (GCA)of the i - th parent*

g_J - *general combining ability (GCA) of the j - th parent*

s_{IJ} - *specific combining ability (SCA) of the cross i x j*

e_{IJK} - *error*

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One of the main objectives of oat breeding program is using method of recurrent selection as an effective breeding procedure to produce improved oat germplasm with higher grain yield potential (Holland et al. 2002; Stuthman et al. 1992). A recurrent selection program for adaptation to diverse environments was successful in improving mean oat (Avena sativa L.) grain yield within and across testing environments.

Evaluation of winter hardiness and drought resistance of selection oat samples that are of interest for solving the breeding tasks was made (Pavlova et al., 2001; Pavlova and Panayotova, 2005, 2006). The genetic control on the character of oat development was studied in order to establish those genes that control winter and spring type of development. Investigated sources of winter genotypes in 24 spring oat varieties give an opportunity of increasing the effectiveness of the selection (unpublished data).

3.2.2. Selection of resistance to crown rust

Virulence diversity of pathogen populations in Bulgaria is studied (Momchilova, 2000). Comparison is made between efficacy of the Pc genes in Bulgaria and other parts of the world – Europe, Middle East and North America. Resistance of collection and selection materials to crown rust is studied and sources of resistance to pathogen are detached.

Stages of immune selection:

- Hybridization
- Backcross of F_1 with the recurrent parent
- Selection upon an infectious background

Including the method of intercrossing hybridization in the selection work aims to enrich the genome of common oat Avena sativa L. with genes, determining higher winter hardiness, resistance to diseases, higher quality of grain and green mass.

The working program includes all sections of selection work with winter and spring oat:

- Maintenance, enrichment and examination of the working collection,
- Hybridization in different crossing schemes and including of the initial hybrid generations in the breeding process;
- Continuing work with the hybrid generations; evaluation of yield (Panayotova, 2004), yield stability, grain quality, drought and winter freeze stress tolerance of advanced breeding lines,
- Testing

3.3 Testing

The breeding lines obtained are tested in hybrid nurseries, control testing, competition variety strain testing and propagation of perspective varieties by using the apprehended agricultural practices (Savova et al., 2005). Needed phenological observations and biometric analyses are made annually. Evaluation of winter hardiness of the hybrid generations is conducted under laboratory conditions by gradual freezing to –15^{o}C; in green house sowing; freezing in environmental test chambers and in field provocative experiments by creating snowlessness under roof structure.

Evaluation of technological qualities of oat is conducted according the quality breeding of the grain in relation to quality of oat products (Savova et al., 2005).

4. NAKED OAT

Recently, breeding efforts focused toward development of naked oat varieties, distinguished for its high content of protein, as well as for its balanced of amino acids profile, beta – glucan content and

ISSN 1313-2539

fats (Panayotova and Tsenov, 2004; Panayotova and Tsenov, 2007). Oat based foods have long been recognized for their health benefits, and it is now generally accepted knowledge that oats make a significant contribution to human health. Except as highly energetic supplement to the food rations of animals, grain of the hulless grain oat finds application in human food (Panayotova and Petkova, 2005). In recent years, we have concentrated on the development of hull-less or naked oat cultivars. This novel oat sheds its fibrous hulls during the harvesting process, thus the hull-less oat grain is higher in protein and energy content relative to its hulled, or covered, counterpart.

5. RESEARCH FACILITIES

Oat breeding research at the Institute relies on various field, greenhouse and laboratory facilities - for technological evaluation of grain, pathology and physiology laboratories, a biochemical laboratory for the relevant analyses - to accomplish the program objectives.

6. PARTNERSHIP

A critical component of this effort is the partnership that exists between the Dobrudja Agriculture Institute-General Toshevo, Institute of Agriculture – Karnobat, Agricultural University – Plovdiv, Bc Institute for Breeding and Production of Field Crops – Zagreb, Croatia. Oat breeding program rely on its associations with other European researchers and on funding from National Centre of Agrarian Sciences, Ministry of Agriculture and Forestry.

7. RESULTS

Promising yield grain potential was demonstrated in some of cultivars and breeding lines of oat breeding program in Bulgaria. Breeding efforts have resulted in developing and releasing of common and naked spring and winter varieties (Radkov et al., 1997; Staneva, 1990) and advanced breeding lines (Panayotova and Mlinar, 2005) that are also being handled through the State Variety Testing release system.

7.1 New varieties and germplasm releases:

Winter oat – Ruse 8; Jubilee 4

Spring oat – Prista 2

Spring forage oat SL-30 (Aleksi 1)

Spring naked oat N-2-7

Spring naked oat G-6

8. FURTHER RESEARCH

Further research is aimed at:

- Developing breeding strategies to improve the efficiency of selection
- Grain yield and quality maintenance under drought stress
- Understanding genetic control of early vigor
- Applying new technologies in order to enhance the efficiency of oat breeding research besides conventional breeding

ISSN 1313-2539

ACKNOWLEDGEMENTS

We express our sincere thanks to Dr. James B. Holland, North Carolina State Univ., USA and to Dr. Harold Bockelman, National Small Grains Collection, Aberdeen ID, USA for their important contributions.

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