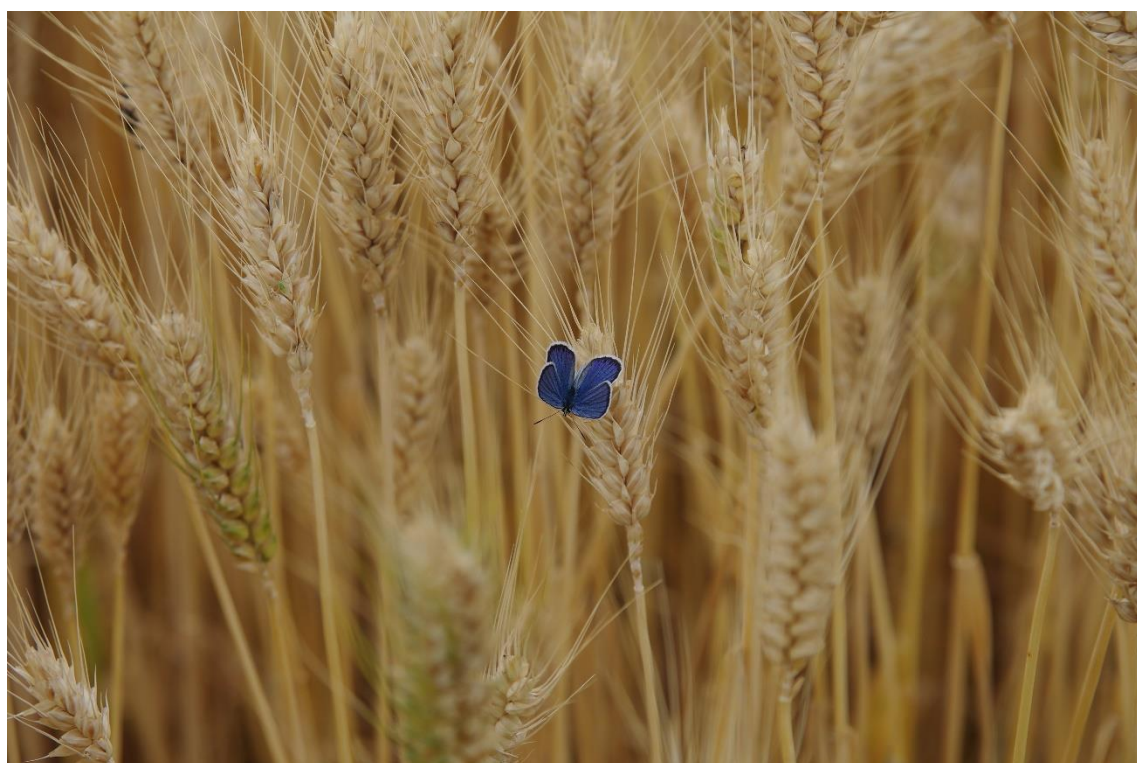


Cereal Breeding - Challenges and Opportunities for Global Improvement

Book of Abstracts of the Eucarpia Cereals Section Conference



Edited by

Bernadett Mihály-Langó, Lajos Bona, Beáta Tóth, Andreas Börner

Szeged
2023

IMPRESSUM

Cereal Breeding - Challenges and Opportunities for Global Improvement
Book of Abstracts of the Eucarpia Cereals Section Conference

Edited by

B. Mihály-Langó, L. Bona, B. Tóth, A. Börner

Organizers of the Conference

Cereal Research Non-Profit Ltd.

EUCARPIA Cereals Section

Published by the

Cereal Research Nonprofit Ltd.

Szeged, Hungary

Szeged, 2023

ISBN 978-963-7352-10-2

SESSION 1

Genetic resources and pre-breeding

**IDENTIFICATION OF A MAJOR COMMON BUNT RESISTANCE QTL IN
MAPPING POPULATIONS DESCENDING FROM PI-166910**

**Magdalena Lunzer¹, Maria Buerstmayr¹, Iris Fallbacher³, Almuth E. Müllner⁴,
Heinrich Grausgruber², Hermann Buerstmayr¹**

¹ Institute of Biotechnology in Plant Production, University of Natural Resources and Life Sciences, Vienna, Austria

² Institute of Plant Breeding, University of Natural Resources and Life Sciences, Vienna

³ AGRANA, Tulln, Austria

⁴ Saatzucht Donau GesmbH & Co KG, Probstdorf, Austria

Once one of the most devastating wheat diseases, common bunt lost most of its importance and frightening qualities with the invention of systemic fungicides that could be applied as seed dressings during the first half of the 20th century. As these chemicals are prohibited in organic farming, common bunt has experienced a come-back during the last few decades, causing an urgent need for resistant cultivars. Due to the lack of research attention this disease got over a long time, knowledge about the genetic architecture of bunt resistance and availability of markers to resistance genes are still rather scarce. We therefore aim to unlock a new genetic resource providing full and durable resistance for research and breeding programs by characterizing it through a QTL mapping study. Four mapping populations (MP) descending from the Turkish landrace PI-166910 (postulated to harbour bunt resistance genes *Bt7*, *Bt9* and *Bt11*) and the bunt differential line for the *Bt11*-gene, PI-554119 ('Elgin' X PI-166910), respectively, were phenotyped for common bunt resistance in artificially inoculated field trials over two, three or four seasons (depending on the MP). Genome-wide marker data was obtained from the 25K wheat SNP array and used for construction of linkage maps for each MP separately and a consensus map. QTL analyses identified a major bunt resistance locus on the distal end of chromosome 6DL and an additional QTL near the proximal end of chromosome 4BS. Together, these loci conferred full resistance against common bunt infection. Additional loci associated with common bunt resistance were found on chromosomes 1B and 2A, both in one out of the total four MPs. The amount of phenotypic variation explained by the detected QTL varied between 29.9% and 73.3%, depending on the MP and the environment. Analyses are ongoing and more detailed results will be available until April 2023.

Keywords: common bunt, *Tilletia caries/laevis*, winter wheat, QTL mapping, resistance breeding

SESSION 2

Grain yield and quality

BREEDING DURUM WHEAT FOR ORGANIC FARMING

Luca Bonfiglioli, Ieva Urbanavičiūtė, Mario A. Pagnotta

Department of Agricultural and Forest Sciences, Tuscia University, Viterbo, Italy

According to the European Union Farm to Fork strategy, at least 25% of the EU agricultural land shall be under organic farming by 2030. However, the lack of wheat varieties specifically adapted and selected for organic conditions and lower input of pesticides and fertilizers in organic production systems result in lower grain yields.

The aim of the study, in the frame of the ECOBREED project (European Union's Horizon 2020 research and innovation program under grant agreement No 771367), was to select suitable durum wheat accessions for organic farming with high grain quality, production, and tolerance to biotic and abiotic stresses.

The trial started in 2018 at Tuscia University, Central Italy, with a preliminary evaluation of 72 durum wheat genotypes, including old varieties, landraces, and new accessions developed in the Central European and Mediterranean areas. The screening was focused mainly on traits important for organic farming, including crop ground cover/competitiveness with weeds, disease resistance/tolerance, grain yield, protein content, etc. From the first-year trial, 27 genotypes were selected and evaluated in the field trial for three years more. The accessions were also characterized genotypically by SSR markers associated with traits of interest.

The study allows us to identify seven accessions suitable for organic agriculture with wide adaptation to different environmental conditions.

Keywords: durum wheat; organic farming; phenotyping; genotyping

BAKING QUALITY OF WHEAT VARIETIES IN THE ECOBREED PROJECT

Stanislav Ježek, Pavel Horčíčka, Ondřej Veškrna¹, Ema Holavová, Irena Bížová

Selgen, a.s.

The purpose of organic farming is to produce healthy and high-quality food in a sustainable manner. Organic wheat cultivation tries to use some traditional agrotechnical practices in order to cope with the limited fertilization use and pesticide exclusion. Only farm fertilizers usage significantly limits the achieved baking quality of wheat in the protein content parameter. It is necessary to involve the most modern scientific knowledge from breeding and phytopathology to breed new wheat varieties suitable for organic farming. The presented work summarizes the multi-year results of the baking quality in set of selected varieties (Ecobreed project) from experiments managed in organic conditions. Further, compares these results in a paired test resulted from conventional experiments.

Keywords: wheat, organic farming, quality

SESSION 4

Environmental adaptation, crop management

RESULTS OF MULTI-YEAR DURUM WHEAT VARIETY TESTS CARRIED OUT IN DIFFERENT MANAGEMENT SYSTEMS

Mónika Cséplő¹, Katalin Puskás¹, Gyula Vida¹, Judit Bányai¹, Klára Mészáros¹, Andrea Uhrin¹, Viola Tóth¹, Heinrich Grausgruber², Luca Bonfiglioli³, Mario Augusto Pagnotta³, Péter Mikó¹

¹ Centre for Agricultural Research, Agricultural Institute, Martonvásár, Hungary

² Department of Crop Sciences, Institute of Plant Breeding, University of Natural Resources and Life Sciences, Vienna, Austria

³ Department of Agricultural and Forest Sciences, Tuscia University, Viterbo, Italy

Durum wheat (*Triticum turgidum* ssp. *durum*) is the second most cultivated *Triticum* species after bread wheat (*T. aestivum* L.) in the world, 33.8 million tons of durum grain were produced worldwide in 2021. In 2022, durum wheat was cultivated on around 35000 ha in Hungary. The acreage under organic farming is constantly growing and the consumers' demands for organic products are also increasing. The objective of this study was to identify phenotypic parameters and yield components of durum wheat varieties of different geographic origin under Hungarian organic and conventional management in three growing seasons. Between 2019 and 2022, unlikely the previous years' average, extreme weather conditions were observed. Durum wheat germplasm was examined in organic, common conventional and low-input breeding trials with 3 replicates and 6 m² plot size. No fungicides were applied in any trial, however, conventional plots were treated with herbicide. During the growing season, early spring ground cover, heading time, plant height, disease severity and lodging were recorded. After harvest, grain yield, grain size (width, length), test weight (TW) and thousand kernel weight (TKW) were determined. Analysis of variance revealed statistically significant effects for the year, management, genotype and their interactions for heading, lodging, yield, grain width and length, TW and TKW. In the case of plant height and ground cover, the management×genotype interaction was not significant. In 2020 and 2022, our latest heading variety, 'Mv Makaróni' headed on 20 and 21 May, respectively, while in 2021, due to the rainy and cold spring weather, 85% of the varieties started to head only after 20 May. Lodging was observed only on the conventional sites in two years. The average yield of the experiment was between 5.79 t/ha and 6.02 t/ha. The varieties 'NS-Zad', 'Sambadur' and 'Mv Vékadur' performed in each trial in each year significantly superior compared to the average of the respective experiment. TW was between 78 kg/hL and 81 kg/hL on average, TKW varied between 42 g and 48 g considering the average of the three field trials. Varieties 'Simeto' and 'Senatore Cappelli' had significantly longer and wider grains compared to the average of the field trials in all three years. Among the naturally occurring pathogens, only powdery mildew was present at each site of each year.

Keywords: *Triticum turgidum* ssp. *durum*, organic, conventional, low-input

The ECOBREED project received funding from the EU's Horizon 2020 research and innovation program under grant agreement No. 771367. The content of the publication reflects the views of the authors and the EU Agency does not assume responsibility for any use of the information contained therein. Project no. TKP2021-NKTA-06 has been implemented with the support provided by the Ministry of Innovation.

SESSION 6

Future challenges and innovations

BREEDING WHEAT FOR ORGANIC FARMING – LESSONS LEARNED FROM THE ECOBREED PROJECT

Heinrich Grausgruber¹, Nadine Bauer², Daniel Cristina³, Matilda Ciucă³, Pavol Hauptvogel⁴, Bojan Jocković⁵, Cristina-Mihaela Marinciu³, Marianna Mayer⁶, Péter Mikó⁶, Primož Titan⁷, Ondrej Veskrna⁸

¹ Institute of Plant Breeding, Univ.Natural Resour. Life Sci., Vienna, Tulln/Donau, Austria

² Secobra Saatzucht GmbH, Feldkirchen, Moosburg/Isar, Germany

³ National Agricultural Research and Development Institute Fundulea, Romania

⁴ Research Institute of Plant Production, Piešťany, Slovakia

⁵ Institute of Field and Vegetable Crops, Novi Sad, Serbia

⁶ Centre for Agricultural Research, Martonvásár, Hungary

⁷ Research Genetics and Agrochemistry, Murska Sobota, Slovenia

⁸ Selgen, a.s., Sibrina, Czech Republic

The ECOBREED project aims to strengthen and/or initiate organic wheat breeding in Europe, especially in countries where the organic sector is still underrepresented. Within the project, organic multi-environment trials (METs) with two winter wheat diversity panels (i.e. early and late maturity) were carried out from 2020-2022 in seven European countries. The METs revealed an extremely high variability in grain yield caused on the one hand by severe drought in some environments, on the other hand by a significant legacy effect of previous mineral fertilization in one test site. Spatial modelling of individual field experiments usually improved trial efficiency significantly, however, in some trials the used field design did not allow an efficient recovering of natural or extraneous variation in the field. Grain yield was generally highest in modern cultivars derived from conventional breeding programmes and lowest for landraces. Tested organic heterogeneous material (OHM) showed medium yields as well as cultivars derived from organic breeding programmes. It is also worth mentioning that in the early maturity panel which was sourced from eastern Europe no genotype derived from a breeding programme devoted to organic farming. The availability of a specific organic VCU test as in Austria, Germany and Czechia seems to be a key driver for the establishment of specific organic breeding programmes. Essential for organic wheat breeding seems to be also a satisfying resistance level against common bunt as severe infection levels were observed at single sites after three seed multiplication cycles. Molecular markers for rust resistance, dwarfing and photoperiod insensitivity genes, as well as genes associated with grain yield under drought conditions did not reveal a specific association pattern with respect to the geographic or breeding programme origin of the germplasm.

Keywords: Disease resistance, marker assisted selection, organic traits, *Triticum aestivum*

This work received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 771367 (ECOBREED).

THE HUNGARIAN PARTICIPATORY ORGANIC WHEAT BREEDING PROGRAM

Péter Mikó¹, Mihály Földi², Mária Megyeri¹, Vida Gyula¹, Dóra Drexler²

¹ ATK, Agricultural Institute, Centre for Agricultural Research, Martonvásár, Hungary

² ÖMKi, Research Institute of Organic Agriculture, Budapest, Hungary

To increase the number of cultivars suitable for organic farming, one of the effective and low-cost concepts is to perform the selection work on the target farm in close cooperation with the farmer. On the basis of this, ATK had sent its organic-suited winter wheat varieties (Mv) and two populations (Mv Elit CCP, Mv Bio2020 Pop) to organic farmers with the aim to start participatory testing (PVS: participatory variety selection) and breeding (PPB: participatory plant breeding) on their farms. These on-farm trials were coordinated by ÖMKi and were run on 3 farms in 2021 completed with 2 additional farms from the following year. Cultivars were evaluated by farmers during the vegetation period, while breeders of ATK visited the farms and they discussed the steps of observation, selection and harvest of trials with the farmers.

In general, Mv varieties had higher grain yield than the populations at each site. Based on the results of the on-farm trials, Mv Elit CCP showed mostly the highest protein and gluten contents and best Zeleny sedimentation value, while the Mv varieties were superior at the farm of Biocentrum (Želiezovce, SK). As only 3-4 Mv varieties could be examined on-farm, replicated small plot trial with 15 entries was also established on one of the farms (Szár, HU). Grain yield of the small-plot trial showed similar rank, showing the populations below the trial average (7.58 t/ha). The variety, Mv Szilke had the highest protein and gluten contents, so as Zeleny sedimentation volume, followed by the two populations. Unlike the other population, test weight and thousand grain weight of Mv Elit CCP were found to be above the trial average.

The two diverse populations are also part of a PPB program, where 3 farmers have made their own positive spike selection in the populations and, after threshing them into bulks, the resulted 6 new subpopulations were examined at two sites (Szár, Martonvásár). Average heading dates of the trial entries and their respective mother-populations were similar, except for the earlier heading subpopulation of Mv Bio2020 Pop selected by Biocentrum. Based on the mean plant height data, the farmer preference could be also revealed: the farmer of Biocentrum had selected taller plants, while the farmer in Szár had selected shorter plants from the populations. Only the subpopulation of Mv Elit CCP selected in Szár could yield more grains than the original population. Grain yield of Mv Bio2020 Pop could be also improved in Szár by 8.6%. The subpopulations selected in Szár and tested in Szár showed better performance than their mother-populations regarding each quality traits (protein, gluten, Zeleny). All subpopulations had higher average test weight and thousand grain weight than their mother-populations, except the Mv Elit CCP subpopulation selected in Füzesgyarmat (HU).

Keywords: organic, participatory breeding, wheat, population

This research has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 771367 (ECOBREED).