Addition of Aegilops U and M chromosomes affects protein and dietary fiber content of wholemeal wheat flour

Marianna Rakszegi*1, István Molnár1, Alison Lovegrove2, Éva Darkó1, András Farkas1, László Láng1, Zoltán Bedő1, Jaroslav Doležel3, Márta Molnár-Láng1 and Peter Shewry2

1Agricultural Institute, Centre for Agricultural Research, Hungarian Academy of Sciences, Martonvásár, Hungary
2Department of Plant Science, Rothamsted Research, Harpenden, UK
3Institute of Experimental Botany, Centre of the Region Haná for Biotechnological and Agricultural Research, Olomouc, Czech Republic
*E-mail: rakszegi.mariann@agrar.mta.hu

Keywords: wheat, Aegilops, dietary fiber, β-glucan, arabinoxylan, U and M genomes

Aegilops geniculata and Aegilops biuncialis are tetraploid species with U and M genomes. They are known to have resistance to biotic and abiotic stresses, but also have unusually high nutritional value (high dietary fiber, Fe and Zn content). The aim of our work was therefore to determine the effects of the addition of Ae. geniculata chromosome on the dietary fiber content and composition of Chinese Spring wheat. Prebreeding material with increased level of dietary fiber was therefore also developed by adding Ae. biuncialis chromosomes to the Mv9kr1 wheat line. In addition to thousand kernel weight (TKW), Kjeldahl protein content and glutenin composition, the contents of dietary fiber (β-glucan and total (TOT) and the water-extractable arabinoxylan (WE-AX)) were measured by spectrophotometric assays of wholemeal samples. The structures of the β-glucan and AX fractions were also compared by enzyme fingerprinting, based on HPAEC (high performance anion exchange chromatography) analysis of oligosaccharide fragments released by digestion with endoxylanase and lichenase enzymes. The chromosomal positions of putative orthologs of the key genes determining these components were also identified using Ae. umbellulata chromosome sequences.

This study showed that the addition of chromosomes 2Ug, 4Ug, 5Ug, 7Ug, 2Mg, 5Mg and 7Mg of Ae. geniculata and 3Ub, 2Mb, 3Mb and 7Mb of Ae. biuncialis into bread wheat increased the seed protein content. Chromosomes 1Ug and 1Mg increased the proportion of polymeric glutenin proteins, while the addition of chromosomes 1Ub and 6Ub led to its decrease. Both Aegilops species had higher proportions of β-glucan compared to arabinoxylan than wheat lines, and elevated β-glucan content was also observed in wheat chromosome addition lines 5U, 7U and 7M. The arabinoxylan content in wheat was increased by the addition of chromosomes 5Ug, 7Ug and 1Ub while water-soluble arabinoxylan was increased by the addition of chromosomes 5U, 5M and 7M, and to a lesser extent by chromosomes 3, 4, 6Ug and 2Mb. Chromosomes 5Ug and 7Mg also affected the structure of wheat arabinoxylan, as shown by the pattern of oligosaccharides released by digestion with endoxylanase. These results will help to map genomic regions responsible for edible fiber content in Aegilops and will contribute to the efficient transfer of wild alleles in introgression breeding programs to obtain wheat varieties with improved health benefits.
Dry matter remobilization and compensatory effects in different plant parts of durum wheat genotypes under water stress

Murat Tiryakioğlu* and Abdulla Sakallı²

¹Department of Field Crops, Faculty of Agriculture, Mustafa Kemal University, 31000 Hatay, Turkey
²Water Resources Management and Organization, Faculty of Marine Sciences & Technology, Iskenderun Technical University, Hatay, Turkey

*E-mail: mtiryaki@mku.edu.tr

Keywords: wheat, water stresses, dry matter change, grain filling, compensatory effect

The main aim of the present study was to analyse changes in performance of CIMMYT-derived spring durum wheat cultivars under conditions typical of those prevailing in the irrigated WANA (West Asia, North Africa) areas. This research was performed in Hatay / Turkey (36° 15΄ N, 36° 13΄ E; D 80 m) in 2009/2010 and 2010/2011. Six durum wheat cultivars were evaluated under two irrigation regimes: irrigation until physiological maturity and irrigation until anthesis. The cultivars were sown on 27 November and 10 December first and second year. Sowing was performed in eight lines of 6 × 1.2 m, each 0.2 m apart. Seeds were sown at 450 seeds m⁻². Whole phosphorus (60 kg P₂O₅ ha⁻¹) was mixed with the soil, while nitrate was given during planting, tillering and stem elongation (30 + 30 + 20 N ha⁻¹). Transport of dry matter from vegetative organs to grains was significantly greater in water stressed conditions (1374 mg plant⁻¹) than in unstressed conditions (1119 mg plant⁻¹). Significant differences have been identified among the varieties in terms of dry matter translocation. The translocation occurred most at Ceylan-95 (1725 plant⁻¹), at least (1589 mg plant⁻¹). In both conditions the maximum dry matter transport to the grain was attributed to the pre-anthesis period (96,51%). A significant negative correlation (r² = −0.48 *) was found between the plant height and the DM transport before flowering in case of stress. In the unstressed condition, a positive correlation (r² = 0.50 **) was found between the transport of the pre-anthesis DM and the transport of the DM after flowering, and vice versa under stress condition (i.e. r² = −0,60 **). As a result, it was determined that the most important dry matter source for the grain was pre-anthesis reservoir in the water stress of the grain filling period. This contribution could reach to 100% according to the stress intensity and there was significant genetic difference among the varieties. In areas like Mediterranean ecology where water stress is frequently encountered, it has been concluded that these issues are very important and that the breeding strategies to be implemented should be taken into consideration.