



*In The Name of God*



Razi University

**Faculty of Agriculture  
Department of Agronomy and plant breeding**

## **PhD Thesis**

# **Mapping QTLs related to drought tolerance in durum wheat (*Triticum turgidum* var durum)**

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## Abstract

Durum wheat (*Triticum turgidum* L. var *durum*) is a tetraploid constituted of A and B genomes (AABB) and is the main source of semolina for the production of pasta, spaghetti, and grain for burghul. Drought stress is the main constraint of the wheat production in many parts of the world. Identifying chromosomal regions associated with drought tolerance in wheat will improve understanding the genetic basis of drought tolerance. New genetic tools and more powerful statistical analyses provide an alternative approach to enhance genetic improvements through the identification of molecular markers linked to genomic regions or QTLs controlling quantitative traits. The main objective of this research was to identify genomic regions associated with drought tolerance in a F<sub>6</sub> population of durum wheat under two environmental conditions (rainfed and supplemental irrigation conditions). A population composed of 130 F<sub>5</sub>:6 recombinant inbred lines (RILs) was derived from the cross of Zardak × 249 (local variety and genotype of Kermanshah province, Iran, respectively). A total of 256 marker loci including 79 microsatellites, 11 EST-SSR, 123 AFLPs, 39 RAPDs and 4 ISSRs were scored. The preliminary genetic linkage map consists of 71 loci on 15 linkage groups. AFLPs and ISSRs markers remained unlinked to linkage groups or were eliminated because they span very large distances. The linkage map covers 913.5 cM with marker loci spaced at an averaged 13.16 cM. Under both environmental conditions, 27 morphological, phenological and physiological traits were evaluated. Interval mapping (IM) method identified 117 QTL peaks with LOD scores  $\geq 2.0$  under rainfed conditions and 96 QTL peaks with LOD scores  $> 2.0$  under supplemental irrigation conditions. Stable QTLs were detected in two environmental conditions for plant height (PH), awn length (AL), flag leaf length (FL), number of seeds per spike (NSPS), chlorophyll florescence (Fv/Fm), peduncle length (PED), date to heading emergence (DHE), date to flowering emergence (DFE) and spikelet density (SpD), suggesting the presence of loci related to stability of these traits under drought stress conditions. Some markers (e.g. BF483631, Xcfd48, Xgwm499, and Xgwm495, Xbarc68) were consistently distinguished for multiple traits (e.g. number of seed per spike (NSPS), spike density (SpD), mean grain weight (MGW), flag leaf length (FL) and date to heading emergence (DHE) under rainfed and supplemental irrigation conditions, indicating broad adaptability and potential use of these markers in marker-assisted breeding. Among all traits, the two-locus QTL analysis detected a total of 12 QTLs with significant ( $P < 0.005$ ) additive × additive epistatic (aa) effects for spike length (aa=-0.195 and 0.506), awn length (aa=-1.30), harvest index (aa=-1.81), excised leaf water retention (aa=1.90) and chlorophyll florescence (aa=0.020). QTL × environment interaction (QE) effect was not significant for none of the traits. This is the first genetic map of a cross involving local genotypes of durum wheat from Kermanshah province of Iran using DNA markers and therefore, it could be used for further detection of QTLs controlling resistance to biotic and abiotic stresses. The results also support the use of identified QTLs to enhance the selection efficiency in plant breeding, especially those showing high explanation rates.

Unlinked AFLP/ISSR/RAPD markers subjected to multiple regression to find association of markers with each of 27 traits under both conditions. Markers XMcaaEact350 (chlorophyll: florescence Fv/Fm), OPD20-760 (grain yield: GY), XMcccEcga290 and XMcaaEact200 (number of seeds per spike: NSPP), McaaEcga140 (plant height: PH), UBC51-850 (relative water loss: RWL2), XMcaaEgtc320 (chlorophyll index: SPAD) were found to be associated with an individual trait under both conditions.

**Key Words:** Drought stress, durum wheat, linkage map, QTL analysis

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