QTL for water stress resistance and water use efficiency in alfalfa

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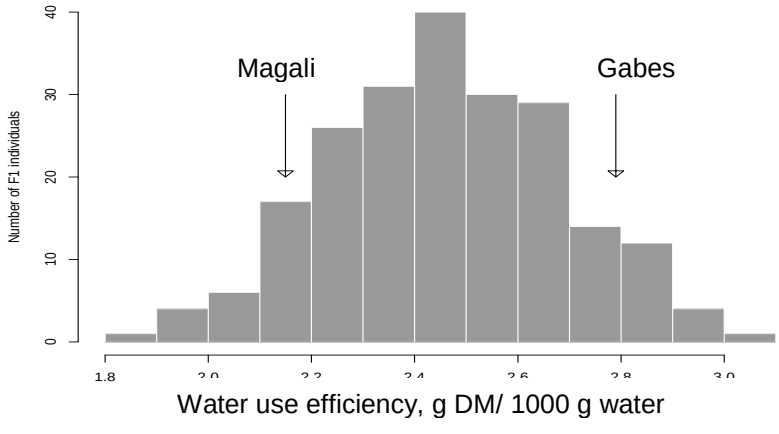
Alfalfa is a perennial crop often grown under dry climates with irrigation. In these conditions, adaptation to water stress conditions gathers two mechanisms: to overcome dry conditions under hot climates without irrigation because of water shortage and to have a better efficiency of water supply. This second parameter, named as water use efficiency by crop physiologists, describes the efficiency of a plant to use water for biomass accumulation. The objective of the study was to detect QTL for water stress resistance and water use efficiency in a mapping population of alfalfa.

A F1 mapping population of 224 individuals was obtained between two plants originating from South of France (Magali) and from a Tunisian oasis (Gabes). The Tunisian plant was supposed to be adapted to water stress conditions. SSR markers were tested for amplification and polymorphism among the parents. Eighty five markers were used, generating 280 alleles. The map, calculated with TetraploidMap software, comprised 8 linkage groups for each parent. Water use efficiency was measured at Montpellier in six growing cycles under well-watered conditions. Plants were transplanted in 2m-high columns, filled with soil. Aerial dry matter was measured at the end of each growing cycle. The consumed water by individual plants was precisely measured. WUE for each plant was calculated as aerial dry matter (g) / consumed water (1000 g). Average value of WUE over the six cycles was calculated. QTL detection was carried out by analysis of variance. In a first step, a simple ANOVA with each allele was made. The significant alleles were then submitted to a multiple ANOVA, using the option SS2 of proc GLM of SAS.

The two parents significantly differed for WUE under irrigated conditions, and the F1 population showed a quantitative variation for this trait (figure). In simple ANOVA, nine markers/alleles had a significant effect on WUE variation. In multiple ANOVA, six markers/alleles has a significant effect, the part of the variation explained (R^2) reached 31.0%. They were located on chromosomes 2, 3 7 and 8. This QTL detection will be completed by the analysis of other traits, as WUE in dry conditions and drought tolerance. The QTLs will be useful to better understand adaptation to water stress conditions in alfalfa and to breed improved varieties.



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