Title Genetic analyses of priming and aging in lettuce (Lactuca sativa L.) seeds and the effect of oxygen on seed longevity

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Abstract

Lettuce (*Lactuca sativa* L.) seeds have poor longevity in storage and exhibit thermoinhibition, or failure to germinate above ~25°C. Seed priming (controlled hydration followed by drying) increases the upper temperature limit (UTL) of germination, but also reduces seed longevity. To explore the connections between seed priming and seed aging, quantitative trait locus (QTL) analyses of seed priming responses and seed aging were conducted using a recombinant inbred line (RIL) population derived from a cross between *L. sativa* cv. Salinas x *L. serriola* accession UC96US23. A single QTL that was responsible for 47% of the phenotypic variation in UTL due to priming collocated with *Htg6.1* , a major QTL from UC96US23 associated with high temperature germination capacity. Introgression of this *Htg6.1* locus into the Salinas cultivar enhanced its responsiveness to priming. This locus contains *LsNCED4* , a gene encoding a key enzyme in the abscisic acid biosynthetic pathway. Primed seeds exhibited reduced expression of *LsNCED4* and increased expression of *LsGA3ox1* and *LsACS1* (genes encoding regulated enzymes in the gibberellin and ethylene biosynthetic pathways, respectively) compared to non-primed seeds when imbibed at high temperatures.

As seeds stored under conventional low humidity and temperature conditions lose viability slowly (i.e., over months or years), the controlled deterioration (CD) test often is utilized to study seed longevity by aging seeds rapidly at elevated temperature and relative humidity. Multiple longevity-associated QTLs were identified using both conventional and CD storage conditions in the same RIL population described above grown in two different years. The QTLs varied with both production environments and aging conditions, and no correlation was found between the seed longevity under conventional and CD conditions for either control or primed seeds. Thus, lettuce seed longevity exhibits strong genotype by environment interactions and CD tests may not be predictive of how lettuce seeds would age under conventional storage conditions.

As reactive oxygen species are proposed to be involved in seed aging, the longevity of control and primed lettuce and onion (*Allium cepa* L.) seeds was assessed when stored in ambient and low oxygen atmospheres. Anaerobic conditions extended seed longevity, particularly under conventional storage conditions.