

## Herbicide resistance-endowing ACCase gene mutations in hexaploid wild oat (*Avena fatua*): insights into resistance evolution in a hexaploid species

### ABSTRACT

Many herbicide-resistant weed species are polyploids, but far too little about the evolution of resistance mutations in polyploids is understood. Hexaploid wild oat (*Avena fatua*) is a global crop weed and many populations have evolved herbicide resistance. We studied plastidic acetyl-coenzyme A carboxylase (ACCase)-inhibiting herbicide resistance in hexaploid wild oat and revealed that resistant individuals can express one, two or three different plastidic ACCase gene resistance mutations (Ile-1781-Leu, Asp-2078-Gly and Cys-2088-Arg). Using ACCase resistance mutations as molecular markers, combined with genetic, molecular and biochemical approaches, we found in individual resistant wild-oat plants that (1) up to three unlinked ACCase gene loci assort independently following Mendelian laws for disomic inheritance, (2) all three of these homoeologous ACCase genes were transcribed, with each able to carry its own mutation and (3) in a hexaploid background, each individual ACCase resistance mutation confers relatively low-level herbicide resistance, in contrast to high-level resistance conferred by the same mutations in unrelated diploid weed species of the Poaceae (grass) family. Low resistance conferred by individual ACCase resistance mutations is likely due to a dilution effect by susceptible ACCase expressed by homoeologs in hexaploid wild oat and/or differential expression of homoeologous ACCase gene copies. Thus, polyploidy in hexaploid wild oat may slow resistance evolution. Evidence of coexisting non-target-site resistance mechanisms among wild-oat populations was also revealed. In all, these results demonstrate that herbicide resistance and its evolution can be more complex in hexaploid wild oat than in unrelated diploid grass weeds. Our data provide a starting point for the daunting task of understanding resistance evolution in polyploids.

**Keyword:** Acc1; ACCase mutation; Herbicide resistance; Hexaploid wild oat (*Avena fatua*); Polyploidy; Resistance evolution