



# Biochemical and molecular basis of resistance to ACCase-inhibiting herbicides in Iranian *Phalaris minor* populations

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## Summary

*Phalaris minor* is a common weed in wheat and barley fields of Iran. Repeated use of ACCase inhibiting herbicides during the last two decades to control this weed has resulted in the appearance of populations of *P. minor* that are resistant to the aryloxyphenoxy propionates (APP) in some wheat fields of the country. Dose–response assays were conducted to investigate the level of resistance in two *P. minor* populations (AR and MR4) which have developed resistance to three APP herbicides, including diclofop-methyl, fenoxaprop-P ethyl and clodinafop propargyl. A high level of resistance in these populations may be due to the presence of an altered ACCase enzyme in these plants, and we hypothesised that one or more mutations in the gene encoding ACCase enzyme are responsible for insensitivity of the enzyme. Results confirmed that resistance in

both populations was target site-based, and molecular studies revealed that substitutions of Trp-2027-Cys and Asp-2078-Gly, respectively in AR and MR4, are responsible for insensitivity of the enzyme in these populations. This is the first report to show that these substitutions endow resistance to APP herbicides in *P. minor*, though other resistant biotypes are reported from elsewhere. These mutations may result in resistance of *P. minor* to some DIM and DEN herbicides. It seems that lack of adequate herbicide and crop rotation has selected plants with different target site mutations, which cause differential responses of the ACCase enzyme to ACCase inhibitors. Additional resistance management practices may be necessary to prevent ACCase-inhibiting herbicides from becoming ineffective over wide areas.

**Keywords:** aryloxyphenoxy propionates, enzyme assay, herbicide resistance, mutation.

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## Introduction

*Phalaris minor* Retz. is an annual grass (Keshavarzi *et al.*, 2007) that grows well in cultivated and waste places in different habitats of Iran (Bor, 1970). This grass is common in Europe and Asia, South and North America, East and South Africa and Australia (Keshavarzi *et al.*, 2007) and infests many winter season cereals

and greatly reduces their yield and quality. This weed in some cases can cause yield reductions of  $\leq 95\%$  in wheat (Chhokar & Sharma, 2008).

Acetyl co-enzyme A carboxylase inhibitors include three chemical groups, aryloxyphenoxypropionates (APP), cyclohexanediones (CHD) and phenylpyrazolins (PPZ). These are common and selective herbicides that are applied post-emergence to control grass weeds in

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