

RESEARCH PAPER

Confirmed resistance to aryloxyphenoxypropionate herbicides in *Phalaris minor* populations in Iran

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Phalaris minor (littleseed canary grass) is a major weed in wheat fields in some parts of Iran. Diclofop-methyl, fenoxaprop-P-ethyl, and clodinafop-propargyl are three acetyl coenzyme A carboxylase (ACCase)-inhibiting herbicides that are commonly used to control this grass in wheat fields. Thirty-four *P. minor* populations with suspected resistance to ACCase-inhibiting herbicides were sampled from wheat fields in the provinces of Fars and Golestan in Iran. The dose-response assays that were conducted under controlled greenhouse conditions indicated that 14 populations were resistant to fenoxaprop-P-ethyl, seven populations were resistant to both fenoxaprop-P-ethyl and diclofop-methyl, and three populations were resistant to fenoxaprop-P-ethyl, diclofop-methyl, and clodinafop-propargyl. These populations showed different levels of resistance to the applied herbicides, compared to the susceptible population. These results suggest that different mechanisms of resistance could be involved. The enzyme assay revealed that the existence of modified ACCase in the three most-resistant populations (AR, MR4, and SR3) is responsible for the resistance of these populations.

Keywords: aryloxyphenoxy propionate, herbicide resistance, *Phalaris minor*.

Wheat (*Triticum aestivum* L.) is a major crop in Iran. In 2007, >6.5 million ha of wheat were planted in this country (Anonymous 2004). *Phalaris minor* is a common weed in some wheat-producing areas, especially in Fars, Khuzestan, and Golestan provinces (Minbashi Moeini *et al.* 2008). According to Singh (2007), littleseed canary grass became the major weed of wheat in northern India during the green revolution in the 1970s. This was due to revised agronomic practises, including the adoption of poorly competitive short-statured wheat varieties, leading to a significant yield reduction. As these practises also have been adopted in Iran, *P. minor* has become a major weed in some areas of Iran. This grass, under high fertility and moisture

conditions, competes vigorously with wheat, reducing yields by $\leq 80\%$ (Singh *et al.* 1999).

Diclofop-methyl (DIC), fenoxaprop-P-ethyl (FEN), and clodinafop-propargyl (CLD) are three aryloxyphenoxypropionate (APP) herbicides that are commonly used postemergence to control grass weeds, such as *Avena* spp. and *Phalaris* spp., in wheat and barley. Aryloxyphenoxypropionate herbicides inhibit the chloroplastic acetyl coenzyme A carboxylase (ACCase) action in the Poaceae family, preventing fatty acid synthesis and reducing the production of the phospholipids that are used in the membranes (Délye *et al.* 2002). Chlorosis, necrosis, and finally the death of plant tissue occur after applying these herbicides (Ball *et al.* 2007). Since their introduction in the 1970s and 1980s, ACCase-inhibitors have been used widely to selectively control grass weeds in crops. Their persistent use has resulted in the appearance of resistant grass weed biotypes. During recent decades, there has been an increasing number of reports of graminicide-resistant weeds. In 2010, Heap (2010) reported graminicide resistance in 38 grass weed species worldwide.

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