Herbicide resistance in *Conyza bonariensis* (L.) Cronquist (flaxleaf fleabane) populations from northeast Victoria and its management in mixed farming systems

By

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Abstract

Conyza bonariensis (L.) Cronquist is a global weed and considered one of the most problematic species in modern agriculture. As a species it has developed resistance to herbicides of nine different active ingredients globally including 5-enolpyruvylskikimate 3-phosphate synthase (EPSPS) inhibitors, photosystem I (PSI) electron diverters, photosystem II (PSII) inhibitors and acetolactate synthase (ALS) inhibitors. Examination of 88 *C. bonariensis* populations collected across northeast Victoria identified that 40% of populations (or plants in specific populations) were resistant to 1080 g a.e. ha^{-1} glyphosate. Multiple resistance was found to glyphosate and the ALS inhibitors chlorsulfuron, metsulfuron-methyl and sulfometuron-methyl in five of the nine populations fully characterised. This is the first reported case of multiple resistance to EPSPS- and ALS-inhibiting herbicides in *C. bonariensis.*

Nine populations collected as part of a resistance survey conducted across northeast Victoria showed varying levels of glyphosate resistance; glyphosate susceptible (GS) biotypes DL4, IR7 and IR11; low level glyphosate-resistant (Gr) biotypes DL3, DL13 and IR14 with Resistance Indices (RI's) between 2.3 and 2.8; and high level glyphosate resistance (GR) biotypes DL19, IR5 and IR10 with RI's over 6. Results of laboratory evaluation for herbicide translocation demonstrated that this was not involved in the resistance present in these populations. GR, Gr and GS populations showed differential accumulation of shikimate suggesting insensitive EPSPS may be involved in the resistance found in these *C. bonariensis* populations. Sequencing both genomic DNA and plasmid DNA identified Pro106-Thr and Pro106-Ser mutations, these mutations have previously been found to confer glyphosate resistance. As these mutations occurred in all three population groups, therefore (an)other mechanism(s) must be contributing to the resistance. Future investigation focused on expression of EPSPS and ABC transporter genes may provide greater insight into the mechanisms conferring resistance in these *C. bonariensis* populations.

C. bonariensis is a successful ruderal invader common on irrigation channel banks in Victoria and New South Wales, Australia. Options approved for herbicide control on channel banks are limited and field experimentation conducted in New South Wales over two years demonstrated that there are no effective herbicide control options for managing the weed in these sites. The lack of effective herbicide options highlights the need for further research into both new herbicides and non-chemical control options.

Little is known about the use of defoliation as a strategic management tool of *C. bonariensis* and information available shows variable results. Field experiments were therefore conducted in Dookie, Victoria and Goolgowi, New South Wales to investigate using defoliation in conjunction with herbicide applications. Greatest control over the two experiments was provided by the sequential applications of paraquat + diquat applied 5-10 days after defoliation; and MCPA + dicamba applied 8-9 days prior to defoliation. These experiments demonstrated effective control could be achieved by the use of defoliation with herbicide application in a double-knock system. In a region where widespread resistance to EPSPS and ALS inhibitors has been demonstrated, additional strategies for management of *C. bonariensis* are critical.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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Intended Publications from this thesis

Multiple resistance to EPSPS and ALS inhibitors in hairy fleabane; Charlotte Aves, John Broster, Leslie A. Weston, Gurjeet Gill and Christopher Preston: Proposed journal – Weed Technology

Exploring mechanisms of glyphosate resistance in *Conyza bonariensis* (L.) Cronquist populations from northeast Victoria; Charlotte Aves, Jenna Malone, Mahima Krishnan, Christopher Preston, Gurjeet Gill and Leslie A. Weston: Proposed journal – Pesticide Biochemistry and Physiology

Control of *Conyza bonariensis* (L.) Cronquist in mixed farming systems; Charlotte Aves, Christopher Preston, Gurjeet Gill and Leslie A. Weston: Proposed journal – Crop and Pasture Science

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Abbreviations

ACCase	acetyl-coenzyme a carboxylase
a.e.	acid equivalent
a.i.	active ingredient
AGRF	Australian Genome Research Facility
ALS	acetolactate synthase
APMA	aminomethylphosphonic acid
ANOVA	analysis of variance
C	Celsius
ED_{50}	median effective dose
EPSPS	enzyme 5-enolpyruvylshikimate-3-phosphate synthase
GR	glyphosate-resistant
GS	glyphosate susceptible
HAT	hours after treatment
IWM	integrated weed management
LB	luria-bertani broth
LSD	least significant difference
PCR	polymerase chain reaction
PEP	phosphoenolpyruvate

PSI	photosystem I
PSII	photosystem II
RI	resistance index relative to sensitive biotype
S3P	shikimate-3-phosphate