

# Characterisation and Management of Herbicide Resistance in Barley Grass (*Hordeum glaucum* Steud.)

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B.Sc. Agriculture (Hons.), M.Sc. (Agronomy)

A thesis by **prior publications** submitted to The University of Adelaide, South Australia

In the fulfilment of the degree of DOCTOR OF PHILOSOPHY

Faculty of Sciences

School of Agriculture, Food and Wine



THE UNIVERSITY  
of ADELAIDE

May 2016

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## **ABSTRACT**

*Hordeum glaucum* has emerged as a problematic weed in cereal and broadleaf crops of South Australia (SA). Recent reports from growers and agricultural advisors in SA have indicated an increase in the incidence of *H. glaucum* in field crops. The increase in the incidence was suspected due to the evolution of herbicide resistance and an increase in seed dormancy in *H. glaucum* populations. Initially, dose response studies confirmed high levels of resistance to (aryloxyphenoxypropanoate) APP acetyl-coenzyme A carboxylase (ACCCase)-inhibiting herbicides in the populations where growers had reported control failures with ACCCase-inhibiting herbicides. As a result of previous reports of an increase in seed dormancy and confirmation of herbicide resistance in *H. glaucum*, it was considered important to investigate herbicide resistance status and seedbank behaviour of field populations of this weed species. Therefore, studies were conducted to characterise herbicide resistance, study seedbank behaviour, inheritance of resistance, fitness penalties associated with herbicide resistance and alternative herbicides for the management of ACCCase-inhibiting herbicide-resistant *H. glaucum* in field peas. A field survey was undertaken in the Upper North and Eyre Peninsula regions of SA in October 2012. Of the 90 *H. glaucum* populations screened for resistance to quizalofop, 14% exhibited some level of resistance and 86% were susceptible. Resistance to ALS-inhibiting herbicides (imazamox+imazapyr and sulfosulfuron) was low (3% to 12% populations). The majority of *H. glaucum* populations emerged rapidly (median  $T_{50} = 8$ d), but some populations displayed an extremely slow emergence pattern with  $T_{50} > 20$  d. There was no direct linkage between seed dormancy and herbicide resistance. The majority of *H. glaucum* populations showed a low level or no seedbank persistence but a few populations persisted for one year (up to 20% seedbank persistence). Dose–response studies confirmed that *H. glaucum* populations had variable levels of resistance to both ACCCase and ALS-inhibiting herbicides, with greater resistance to ACCCase-inhibiting herbicides. Gene sequencing



confirmed the presence of previously known mutations Ile-1781-Leu, Ile-2041-Asn and Gly2096Ala in the *ACCase* gene of some *H. glaucum* populations. No amino acid substitution was found in the *ALS* gene of resistant populations, but the reversal of SU resistance by malathion (a cytochrome P450 inhibitor) and susceptibility to sulfometuron suggest that non-target site mechanisms confer resistance to ALS-inhibitors in this species. The mode of inheritance of resistance to ACCase-inhibiting herbicides was identified as a single gene with a partially-dominant allele. Fitness studies conducted under intraspecific competition and/or interspecific competition in pots and the field with wheat and lentil revealed that the amino acid substitution at 1781 position of the ACCase gene did not impose any fitness costs, but there was some evidence for fitness cost associated with Ile-2041-Asn mutation in *H. glaucum* populations. To identify alternative herbicides to control ACCase-inhibiting herbicide-resistant *H. glaucum*, a range of pre- and post-emergent herbicides were examined in field peas. The results of this investigation suggest that propyzamide or pyroxasulfone applied PP and POST imazamox could be used effectively in the field for the management of ACCase-inhibiting herbicide-resistant *H. glaucum* in South Australia.

## **PUBLICATIONS ARISING FROM THIS THESIS**

- Shergill LS, Malone J, Boutsalis P, Preston C, Gill GS (2015) Target-site point mutations conferring resistance to ACCase-inhibiting herbicides in smooth barley (*Hordeum glaucum*) and hare barley (*Hordeum leporinum*). *Weed Science* 63(2):408-415
- Shergill LS, Fleet B, Preston C, Gill G (2015) Incidence of herbicide resistance, seedling emergence and seed persistence of smooth barley (*Hordeum glaucum*) in South Australia. *Weed Technology* 29(4):782-792
- Shergill LS, Malone J, Boutsalis P, Preston C, Gill G (2015) Multiple resistance to ACCase and ALS-inhibitors in *Hordeum glaucum* Steud. *Pest Management Science*: Submitted
- Shergill LS, Malone J, Boutsalis P, Preston C, Gill G (2015) Inheritance and mechanism of quizalofop resistance in smooth barley (*Hordeum glaucum*) biotype from South Australia. *Weed Science*: Submitted
- Shergill LS, Boutsalis P, Preston C, Gill G (2015) Fitness costs associated with 1781 and 2041 ACCase-mutant alleles conferring resistance to herbicides in *Hordeum glaucum* Steud. *Crop Protection*: Submitted
- Shergill LS, Fleet B, Preston C, Gill G (2015) Management of ACCase-inhibiting herbicide-resistant smooth barley (*Hordeum glaucum*) in field pea (*Pisum Sativum*) with alternative herbicides. *Weed Technology*: In-press
- Shergill LS, Preston C, Boutsalis P, Malone J, Gill G (2014) Amino acid substitutions in ACCase gene of barley grass (*Hordeum glaucum* Steud.) associated with resistance to ACCase-inhibiting herbicides. Pages 7-10 In Proceedings of 19th Australasian Weeds Conference Hobart, Tasmania, Australia: Tasmanian Weed Society

## **ACKNOWLEDGEMENTS**

First and foremost, I would like to thank God. In the process of putting this book together I realized how true this gift of writing is for me. You have given me the power to believe in my passion and pursue my dreams. I could never have done this without the faith I have in you, the Almighty.

Further, I would like to express my appreciation to all who have been a part of this journey. It has been a great privilege to spend several years of my life in the School of Agriculture, Food and Wine at The University of Adelaide, and its members will always remain dear to me. I would like to express my special appreciation and thanks to my supervisors Assoc. Prof. Gurjeet Gill and Christopher Preston, they have been a tremendous mentor for me. I would like to thank them for their constant support, competent guidance, insightful suggestions, and constructive criticism which helped to complete my research and degree successfully. I would also like to thank Dr Peter Boutsalis for his support and introducing me to herbicide resistance testing, and Dr Jenna Malone, who introduced me to molecular techniques.

I would like to express my gratitude to Benjamin Fleet for his friendship, support, encouragement and patience while working together. I couldn't imagine completing my field experiments without his support and help. I am also grateful to the assistance I received from the Weedies group at The University of Adelaide and growers within Australia.

My acknowledgement will never be complete without the special mention of my dearest friend of last ~10 years, Rupinder Saini. Her support, encouragement, friendship and belief in me were a treasure. I am forever indebted to her, thank you for everything.

Sincere thanks to all my friends in Adelaide and overseas for their selfless help, friendly advice, fruitful company, immense caring and understanding during my candidature.

I would also like to thank the Australian Centre for International Agricultural Research (ACIAR) for awarding me John Allwright Fellowship, which was indeed a life changing experience. I would like to acknowledge the financial, academic and technical support of The University of Adelaide and its staff. I am also obliged to the Grains Research Development Corporation (GRDC) for funding part of my research.

Most importantly and sincerely, a special thanks to my family, none of this would have been possible without the love and patience of my family. Words cannot express how grateful I am to my parents for all the sacrifices that they've made on my behalf, you're my inspiration. Your moral values, love, support and prayers were what sustained me thus far.