CROP SCIENCE SOCIETY
OF SA INCORPORATED
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NEWSLETTER

Welcome to the August issue of the Crop Science Society of SA newsletter

Dear CSSSA Members,

Welcome to the August issue of the Crop Science Society of SA.

In this month's newsletter we explore:

- Member in focus - David Keetch
- Trends in Group B herbicide resistance in prickly lettuce populations across the Mid North and Yorke Peninsula
- Upcoming events
    - 2021 Spirit of Excellent in Agriculture Awards
    - SARDI root health workshops
    - Acid Soils SA liming workshops
    - Regional nodes roadshow

We hope you are keeping well. Please contact us if you have any requests for content of information.

Kind regards,

Dan Petersen
President, Crop Science Society of South Australia

Member in focus – David Keetch, new Vice-President CSSSA

I have been working as an agricultural researcher for over 16 years and have been in my current role as a Nufarm Field Development Officer since 2017. I have a strong interest in herbicides, managing herbicide resistance and enjoy playing a role in developing solutions for farmers and agronomists. Being a part of the Portfolio Solutions team at Nufarm Australia is very satisfying because we have a culture that fosters creativity and ideation, which I believe are key components of successful product development.

I am a recent graduate of the ARLF Australian Agribusiness Leadership Program and during my journey through that program I felt that I'd like an opportunity to contribute more to the industry outside of my employment. I see taking on the Vice President role of CSSSA as a great starting point to making that contribution and having an opportunity to improve on the communication of science to not only those within the industry but perhaps also to urban Australia as well.

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Trends in Group B herbicide resistance in prickly lettuce populations across the Mid North and Yorke Peninsula

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Research highlights

- Recent surveys in the Mid North and Yorke Peninsula indicate that resistance to the IMIs is becoming more common
- Genetic testing of prickly lettuce collected in these surveys has revealed that IMI resistance can be caused by at least five different amino acid substitutions
- One of these substitutions is new to herbicide resistance research, and causes stronger resistance than other known mutations

Background and Aims

Broadleaf weeds such as prickly lettuce are difficult to control in lentils because there are relatively few herbicides registered for post emergent control of broadleaf weeds. IMI-tolerant lentils have been a useful tool for growers but resistance to the Group B herbicides, including the IMIs, is common. Furthermore, prickly lettuce produces large amounts of easily wind-dispersed seeds that complicate management efforts.

It is known that resistance to the group B herbicides in prickly lettuce is caused by mutations in the acetolactate synthase (ALS) gene. The Group B herbicides control weeds by targeting the protein coded by the ALS gene. Certain genetic mutations result in a different amino acid being coded at a critical point in the DNA, which can change the protein structure. This often reduces the ability of the herbicide to bind to the protein. However, many different mutations of the ALS gene have been reported in different weed species, and these do not always have a consistent effect across chemical families of the Group B herbicides.

This research will determine the extent of herbicide resistance in prickly lettuce through the main lentil-production areas of South Australia (Mid-North and Yorke Peninsula), and study the mechanisms of resistance. It will determine what mutations are present, examine spatial patterns of mutation distribution, and determine their consequences for herbicide resistance.

Brief Methodology

Populations of prickly lettuce were sampled randomly from paddocks across the Mid North and Yorke Peninsula and screened for resistance to an SU and an IMI herbicide. Tissue samples were collected from these plants, as well as a large number of plants from a single grower paddock on the Yorke Peninsula, and DNA was extracted to sequence the ALS gene and search for mutations. Seed was collected from at least one plant with each of the different mutations identified and subjected to a herbicide dose-response experiment to quantify the effect of different mutations.

Results and Discussion

Herbicide resistance screening

Screening of the field-collected samples found survival to the SU's ranged from 50-100% (average 91%), and 60-100% for the IMIs (average 95%), and consequently all populations sampled were classified as resistant. Comparison with earlier surveys (screened with SU only) of a similar area indicate that resistance may have increased (Table 1).

Table 1. Percentage of prickly lettuce populations classified as resistant during surveys conducted in the Mid North and Yorke Peninsula in 1999, 2004 and 2019.

	SU		IMI	
Survey year	Resistant populations (%)	n	Resistant populations (%)	n
1999	66	58	-	-
2004	82	11	-	-
2019	100	27	100	23

ALS gene mutations

Five different amino acid substitutions for the wild-type (susceptible) proline were found across all samples tested (Table 2). All amino acid substitutions except one (phenylalanine) have been reported in prickly lettuce or other weed species before. Phenylalanine constitutes a two base-pair change from the wild-type proline. In this case, two independent mutations have occurred to convert from a proline to a phenylalanine.

Table 2. ALS gene DNA sequence variations discovered, resulting amino acid changes and consequences for herbicide response. Mutations with respect to the wild-type are highlighted.

DNA sequence	Amino acid coded	Herbicide response
CCC	Proline	Susceptible (wild type)
CAC	Histidine	Resistant
CTC	Leucine	Resistant
TCC	Serine	Moderately resistant
ACC	Threonine	Resistant
TTC	Phenylalanine	Highly resistant

All amino acid substitutions found across the Mid North and Yorke Peninsula were also found in the extensively-sampled grower paddock. Some spatial patterns were evident (Figure 1). For example, histidine substitutions were much more common in the Mid North, while serine substitutions were more common on the Yorke Peninsula. Threonine was equally common in both regions, and leucine and phenylalanine were both uncommon. These trends were also reflected in the paddock samples.

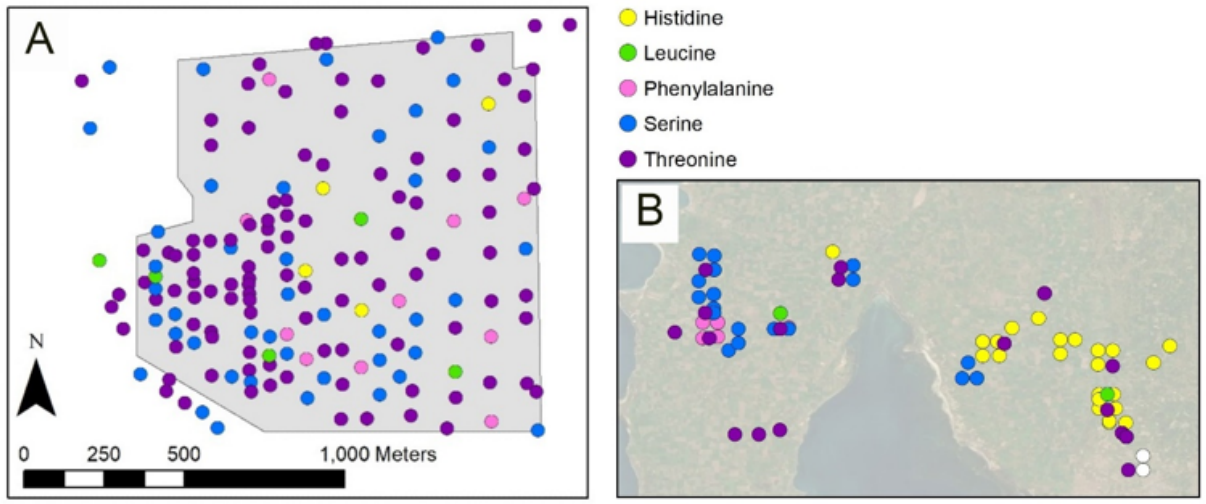


Figure 1. Map of amino acid substitutions identified in prickly lettuce sampled in the grower paddock (A) and across the Mid North and Yorke Peninsula (B). Samples shown in Figure 1B are often several individuals sequenced from a single GPS recording so markers are staggered and locations are approximate. White circles are Proline (wild type).

Dose response analysis

Susceptible populations carrying the wild-type proline were easily controlled at the field rate of metsulfuron-methyl. All other amino acid substitutions in ALS of prickly lettuce resulted in LD_{50}s well above the field rate, but not significantly different to each other. For the IMI herbicides, serine substitutions resulted in moderate resistance (LD_{50} approximate to the field rate), and phenylalanine substitutions caused very high levels of resistance, while all other substitutions were similar to each other.

The consequences of the stronger resistance caused by the phenylalanine substitution remain to be fully explored. Since all other substitutions already cause resistance levels far exceeding the field rate, the consequences of this stronger mutation may not be reflected in the proportion of survivors in the field following herbicide application. However, stronger levels of resistance could potentially be reflected in reduced herbicide injury and greater seed production. The effect of the phenylalanine substitution on seed production is a possible future direction for continuation of this work.

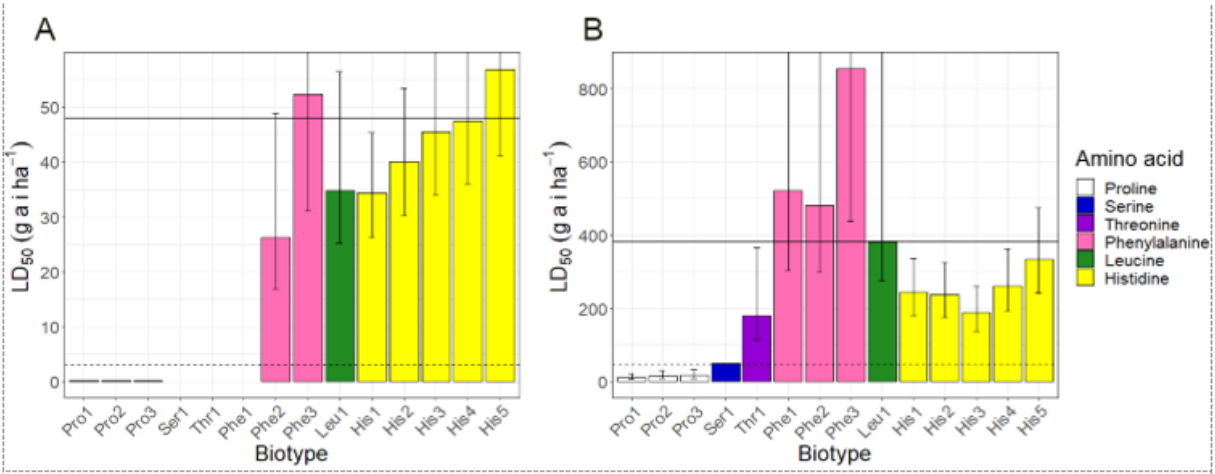


Figure 2. Lethal dose to 50% of individuals (LD_{50}) of prickly lettuce populations with different amino acid substitutions following treatments with SU herbicide metsulfuron-methyl (A) and IMI herbicide Intervix (B). Dashed horizontal lines indicate the field rate, solid horizontal lines indicate the highest experimental dose rate applied and error bars represent 95% confidence intervals.

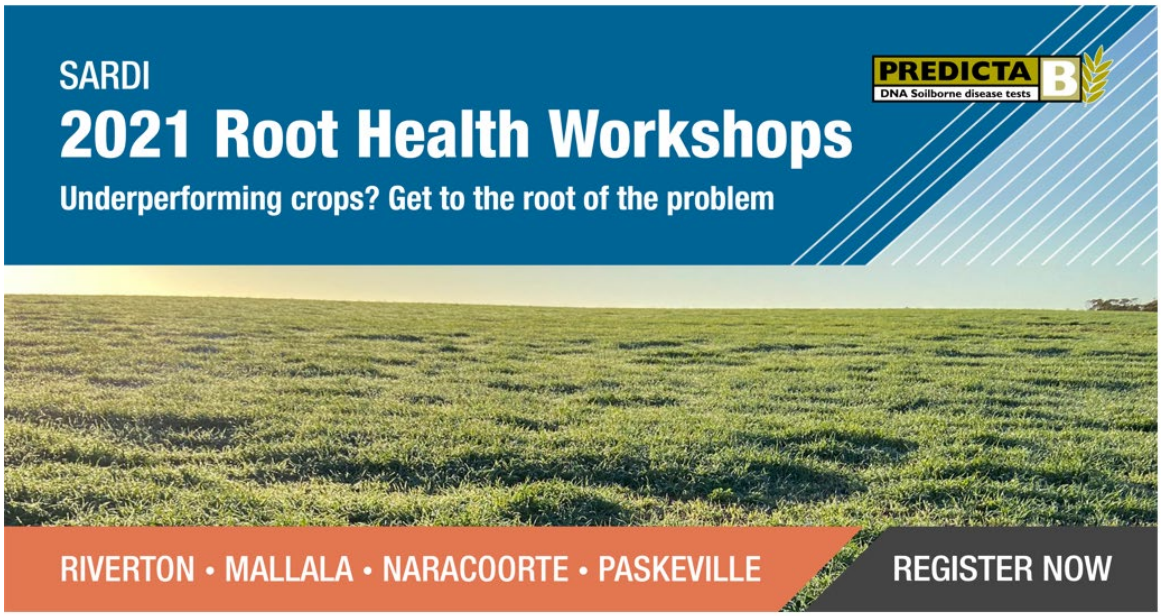
The results of this study indicate that the vast majority of prickly lettuce populations in this region are resistant to Group B herbicides and resistance is conferred by a variety of different mutations. While these mutations show some spatial structure, they are widely distributed and highly variable even at the scale of a single paddock. This reflects the prolific production of highly mobile seed in this species. A new amino acid substitution with elevated levels of resistance was also identified, demonstrating the ability of these weeds to acquire new mutations with additive effects on resistance when exposed to continued selection pressure. Group B herbicides have a high propensity for selection of resistance, and their continued use may have additional consequences for prickly lettuce, as well as other weeds.

Acknowledgements
This research is supported by an Australian Government Research Training Program Scholarship and a GRDC Grains Research Scholarship. Thanks are also extended to the growers who accommodated field trials and sampling as part of the project.

Upcoming events

Friday, October 29 from 6-10.30pm at
The Terrace Function Centre
51 Barnet Rd, Evanston

For more information:
Phone 8249 7581 | agbureau@ruralbusinesssupport.org.au | agbureau.com.au



Growers and advisors are invited to attend this SAGIT funded workshop to investigate the impacts of soil-borne root diseases on plant health.

THE WORKSHOP WILL:

- Explore the main soil-borne root diseases in your region, providing an insight into symptoms and management.
- Include an interactive session where you get to score the root health of your own cereal and pulse crops.
- Provide opportunity for discussions with SARDI pathologists.
- Demonstrate how PREDICTA®B can be used to make better informed variety, rotation and paddock management decisions.

POINTS TO NOTE:

- All participants are required to bring along cereal or pulse plants. We will post you sample bags with further instructions.
- Plants can be assessed by PREDICTA®B at participants expense to confirm diagnosis. Results will be sent to the owners within 4 weeks post workshop and will be followed up with an online consult.
- Includes resource material (back-pocket guide)

COST

The workshop costs $35 Inc. GST.
This includes morning and or afternoon tea plus workshop materials.

REGISTRATION

Registration is essential. Head to: https://bit.ly/3rXvaL4

WORKSHOP LOCATIONS

RIVERTON - 2 SEPTEMBER
Riverton Town Hall
9.00am - 12.00pm

MALLALA - 7 SEPTEMBER
Mallala Football Club
9.00am - 12.00pm

NARACOORTE - 16 SEPTEMBER
Naracoorte Town Hall
2.00pm - 5.00pm

*Presented in collaboration with MacKillop Farm Management Group Soil Forum being run from 9am-1pm.**

PASKEVILLE - 6 OCTOBER
Paskeville Community Centre
9.00am - 12.00pm

A free half-day workshop providing growers and advisers with information, resources and tools to improve the management of surface and subsurface soil acidity in South Australia.

Hear from leading experts on the cause and effect of soil acidity, soil pH mapping and NDVI, lime sources and application rates, recent research results from current lime trials across SA and onfarm decision support models.

About the project:
Acid Soils SA is a collaborative project which provides resources, information and research updates to underpin best practice surface and subsurface soil acidity management in South Australia.
The project will generate new information regarding lime movement and effectiveness when applied to the surface of different soils and environments in modern farming systems. It will also work to identify, develop and validate novel acidity management practices such as lime forms, placement and incorporation methods, such as spading or topsoil slotting.

To register click here:
https://bit.ly/2W72ZNY
Registration is essential to ensure a COVID-19 safe event.

SA Drought Resilience Adoption and Innovation Hub

Regional Nodes Roadshow Workshops
FREE COMMUNITY WORKSHOPS TO INFORM
SA DROUGHT HUB PRIORITIES – REGISTER NOW

A major step towards preparing South Australian farmers, industries and regional communities for future droughts is about to be taken.
The South Australian Drought Resilience Adoption and Innovation Hub is preparing to conduct a series of regional roadshow workshops to identify each region's priorities for building drought resilience.
Workshops will be held in Wudinna, Port Augusta, Loxton, Orroroo, Roseworthy and Naracoorte.
A strong farmer representation is being encouraged and the workshops are open to all regional community members – not just those who work in agriculture – who are keen to contribute ideas about strategies to strengthen local drought preparedness and endurance.
The workshops will be vital in defining and co-designing the future activities of the Hub and five regional Nodes. The workshops are the most important opportunity to begin to identify the priority activities the SA Drought Hub should be delivering for the next three years.
They will be positive and highly interactive meetings involving regional Hub partners, primary producers and other stakeholders where the practices and technologies each region needs to build their drought resilience will be brainstormed.

Workshops will be held on the following dates:

Thursday, August 26 – **Eyre Peninsula (medium & low rainfall)**
Wudinna Community Club, 9am-12.30pm (incl morning tea)

Friday, August 27 – **Pastoral Zone (rangelands)**
Port Augusta Central Oval, 10.30am-2pm (incl lunch)

Monday, Sep 13 – **Riverland-Murraylands (low rainfall & irrigated)**
Loxton Hotel, 5.30pm-8.30pm (incl dinner)

Tuesday, September 14 – **Upper North (low rainfall)**
Orroroo – Blacksmith's Chatter, 10.30am-2.00pm (incl lunch)

Thursday, September 16 – **Mid North (medium rainfall)**
Roseworthy – University campus, 7.00pm-10.00pm (refreshments)

Friday, September 17 – **South-East (high rainfall)**
Naracoorte Town Hall, 12.00-3.45pm (incl lunch)

Registration is essential to ensure a COVID-safe event.

Register Now