CROP SCIENCE SOCIETY OF S.A. INCORPORATED

C/- WAITE CAMPUS
P.M.B No 1, GLEN OSMOND, SOUTH AUSTRALIA 5064

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The Crop Science Society of SA is combining with the Coomandook Ag Bureau

for a regional meeting

Wednesday, February the 20th <u>7.30pm</u> at Coomandook Church Hall, 3223 Dukes Hwy, Coomandook.

Melissa Fraser (PIRSA Rural Solutions) overcoming soil constraints on sandy soils. Amelioration strategies to boost crop production.

Craig Farlow (Incitec Pivot) on seeding fertiliser decisions, potential impacts from fertiliser toxicity and other related crop establishment issues.

Light supper will be available at the venue after the meeting.
RSVP to cropsssa@yahoo.com or on 0447 541 654.

All visitors welcome!

Please follow this link for information on the 22nd Australasian Weed's Conference in Adelaide October 2020
http://wmssa.org.au/events/

Crop Science Society recognizes three new life members.

Since 1975 the Crop Science Society of South Australia Incorporated (CSSSA) has advocated for the use of sound science to provide improvements in agricultural crop production for South Australian producers. CSSSA is an active organisation of farmers, farming consultants and agricultural research scientists. It was felt that a society was needed to provide a forum for the exchange of information between people in academic and applied fields; between research, teaching, extension workers, farmers and marketing representatives.

CSSSA provides a forum for the interchange of ideas from a membership extending beyond that spanned by any existing organisation. Currently, the society has approximately 400 members from rural and metropolitan SA, as well as a small interstate membership. Meetings are held on the third or fourth Wednesday of the month at the University of Adelaide's Roseworthy campus.

At an invitation dinner at Gawler on the evening of the 20^{th} December the Society recognized three new worthy recipients.

The evening was an opportunity for five of the previous Life Membership recipients, committee members, members & member's wives to meet before the Christmas break.

John Both was an influential agriculture researcher up until November 2018 when he retired from Nufarm Limited after 27 years with them. John led & conducted extensive research which was critical for the creation of broader use patterns of existing chemistry, as well as development of new products to bring to market. He influenced and aided many farmers and Agronomists in their daily operations. John was also a past Crop Science President and committee member and was influential in helping to shape local planning policy with respect to the Ag/urban interface. He also aided in communication with industry and government on matters of chemical drift & spray management.

Peter Smith has recently retired from his position as Assistant Principal at Urrbrae Agricultural High School after 31 years with the school. Peter had a back ground in animal studies through the University of Adelaide but was appointed the Grains lead with Urrbrae when he started teaching as an Ag teacher. With linkages to Crop Science through a past life membership recipient Tony Rathjen, Peter has been a regular participant at our regular meetings, and been influential through committee positions & most recently as the elected Secretary. Peter is also a contributor to the Royal Agriculture & Horticulture Show society & Deputy Chair of their Grains & Fodder Committee. He was instrumental in developing the new National Grain & Fodder Innovation awards, presented at the Royal Adelaide Show for the first time this year.

Peter Cousins is an Agricultural Consultant based at Crystal Brook in the Mid North. Peter has had extensive experience in the industry, and has been extremely busy with important activities such as spray drift management and planning policy. He also contributes through organisations such as the Hart Field Day Group. Peter has been a strong Crop Science advocate. Most recently Peter has taken on a Director's position with Grain Producers SA (GPSA).

All three recipients were present to receive their awards and were warmly congratulated by the members present.

Yours sincerely,

Craig Davis.


CROP SCIENCE SOCIETY
Life Membership
awarded to
Peter Cousins
CROP SCIENCE SOCIETY
Life Membership
awarded to
John Both
CROP SCIENCE SOCIETY
Life Membership

Weed Resistance in the SA Mallee and South East between 2007 and 2017

19 December 2018

Acknowledgement: this study was fully funded by the GRDC Project number UA00020

Peter Boutsalis, Gurjeet Gill & Christopher Preston

Summary: A random weed survey of 238 paddocks was conducted across the cropping zone of the SA Mallee and South East in mid-December 2017. Trifluralin resistance in ryegrass was detected in 68%, 41% and 14% of paddocks in the southern Mallee, South East and northern Mallee, respectively. This represents a reduction in trifluralin resistance in the South East and little change in either Mallee region. No increases in resistance to Group A and B herbicides was detected. The availability of alternative mode of action herbicides is likely to have contributed to the reduction in Group A, B and D resistance detected in 2017 compared to the previous survey in 2011. In 2017, additional pre-emergent herbicides were included with resistance to Group J and K herbicides confirmed, predominately in the South East. Alarming levels of resistance to glyphosate was once again detected in the South East with 27% of ryegrass samples exhibiting resistance compared to 16% in 2012. Glyphosate resistance was also detected in 4% of samples from the southern Mallee. Ryegrass from the South East was also tested with paraquat with 7% of ryegrass samples confirmed resistant. Out of 56 brome samples collected in the Mallee regions, on average half of them exhibited resistance to Atlantis. Similarly in barley grass, 41% of samples exhibited resistance to Atlantis. No resistance to Intervix, quizalofop or glyphosate was detected in brome or barley grass. In wild oats, out of 31 collected samples, 10% exhibited resistance to clodinafop with no resistance to Atlantis or triallate. Seven phalaris samples were collected from the South East and none were resistant to Atlantis or clodinafop (data not shown). Sowthistle was the most prevalent broadleaf weed species equally distributed between the Mallee (58 samples) and South East (60 samples). Group B resistance was highest in the Mallee and 2,4-D resistance highest in the South East. In the Mallee, wild turnip was frequently encountered with 31 samples collected. No resistance to Atrazine, Brodal or 2,4-D was

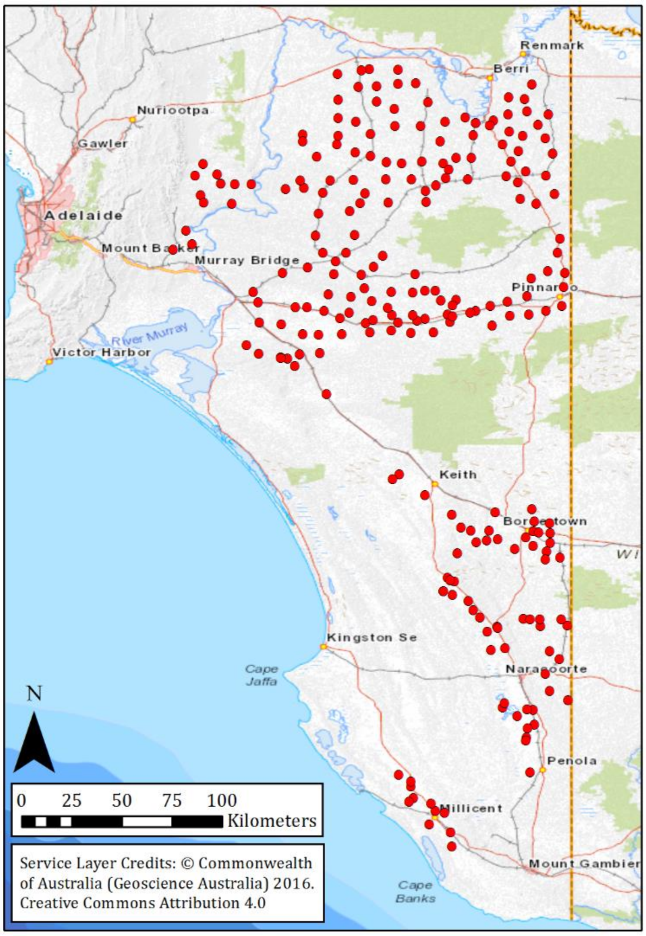
identified. Group B resistance was however identified in 23% of samples to sulfonylureas and 16% to imidazolinones. Wild radish was collected from 13 fields, with 46% resistant to chlorsulfuron, 23% to Intervix and 38% resistant to 2,4-D. No resistance to Brodal or glyphosate was detected. In 5 Indian hedge mustard samples collected, no Group B Group C, 2,4-D or glyphosate resistance was identified.

Methods and materials

A random weed survey was conducted across the cropping zone of the SA Mallee and South East in mid-December 2017. A total of 238 paddocks were surveyed: northern Mallee (102 paddocks), southern Mallee (63 paddocks) and South East (73 paddocks (73). This is the third survey conducted in the eastern part of the South Australian cropping zone with the first survey conducted in 2007 and the second in 2012. Paddocks were selected from cropping areas. Pasture and oat crops were not included. Sites were chosen when they were at least 10km apart in the northern Mallee region and 5km for the southern Mallee and South East regions from the previously surveyed paddock as determined with an in-car GPS unit. The most prevalent weed species across the entire zone was ryegrass followed by sowthistle. Brome, barley grass and wild turnip were more common in the northern Mallee. Wild oats, wild radish and sowthistle were dominant in the South East. Phalaris was only encountered in the South East Other weed species that were observed but not collected (not part of the survey species list) were prickly lettuce and melon. No weeds were encountered in 11% of paddock in the northern Mallee, 5% of the paddocks in the southern Mallee and 3% of the paddocks in the South East.

Seed heads from plants that were present at sampling were collected. These seeds can originate from resistant survivors, herbicide misses, or late germinators. Where resistance was confirmed, it indicated that a particular paddock contained resistant individuals. It is difficult to establish whether the pot trial results would represent the resistance status of the entire paddock, particularly as resistance tends to occur in patches. What is does confirm however, is the presence or absence of resistance. The seed samples were tested in outdoor pot trials between April –July 2018 in order to allow for dormancy to naturally break and treat when weed control would occur in the field. Recommended field rates were applied with a twin nozzle boom cabinet sprayer. A weed sample was classed as resistant if at least 20% of plants survived in the pot test. Samples with less than 20% survival were not classed as resistant.

Figure 1: Paddocks surveyed in the 2017 SA Mallee and South East survey. Red spots are survey locations.



Results & Discussion

Weed Distribution

Table 1: Distribution of weed species encountered in the northern and southern Mallee in November and in the South East. Results are the percentages (%) of weed species that were encountered. The number of fields surveyed in each region on the last line of the graph.

CROP	Northern (%)	Southern (%)	South East (%)	Entire zone (%)
Ryegrass	54	75	89	70
Brome	38	37	3	27
Barley grass	38	22	5	24
Wild oats	7	6	27	13
Phalaris	0	0	10	3
Sowthistle	30	41	63	43
Wild radish	0	3	16	6
Wild turnip	29	13	0	16
TOTAL FIELDS	102	63	73	238

Resistance in ryegrass

Pre-emergence herbicides: No increase in trifluralin resistance was detected from the 2012 survey in 2017. This could be as a result of use of alternative mode of action herbicides now readily available such as Boxer Gold and Sakura reducing the selection pressure from trifluralin. A low incidence of resistance to Group J and K herbicides was detected in both Mallee regions and greater incidence in the South East. Pre-existing enhanced metabolism mechanisms coupled with selection with Group J and K herbicides is most likely the reason for the detected resistance.

Group A herbicides: Little change in resistance to the cereal selective Group A herbicides, dicolofop and pinoxaden was detected. Resistance to the Group A's remains low in the

Mallee regions indicating significant opportunities for using these herbicides. In contrast, widespread resistance to diclofop and pinoxaden in the South East makes effectiveness of these herbicides difficult. A lower level of clethodim resistance was detected in the South East in 2017 than in previous years at the lower rate. The reason for this is uncertain.

Group B herbicides: Resistance to both sulfonylurea and imidazolinone herbicides has not increased over the last 5 years. The results indicate that in approximately 50% of paddocks, Group B herbicides could be effective. In the pot testing, sulfometuron is preferred over chlorsulfuron as it is more reliable in detecting for sulfonylurea resistance in pot trials and also indicates the level of Group B target site resistance. Ryegrass has been shown to be resistant to chlorsulfuron by two mechanisms, enhanced degradation or target site resistance. However, survival to sulfometuron usually indicates target site resistance.

No Glyphosate resistance was detected in the north Mallee whereas 4% was detected in the southern Mallee. The highest incidence of glyphosate resistance detected in any region was detected in the 2012 South East resistance(16%); this result was superseded with the 2017 results showing 27% of the paddocks exhibiting glyphosate resistance. This is the highest incidence of resistance to glyphosate in ryegrass in any other Australian cropping region. Additional testing with paraquat was conducted for the South East ryegrass samples, with 7% confirmed resistant.

Table 2. Percentage of paddocks where herbicide resistant annual ryegrass was identified in the SA Mallee and South East SA in 2007, 2012 and 2017 surveys after treatment with herbicides in pot trials. Populations were considered resistant if survival was ≥ 20% in the pot trials.

ANNUAL RYEGRASS	North Mallee			South Mallee			South East		
Herbicides	2007	2012	2017	2007	2012	2017	2007	2012	2017
Trifluralin	5	20	14	35	69	68	43	78	41
Avadex			5			0			23
Boxer Gold			0			0			5
Arcade			0			0			5
Sakura			0			2			5
Butisan			3			2			9
Kerb			0			0			0
Hoegrass 1.5L/ha	2	9	14	12	30	31	58	90	84
Axial 300ml/ha	2	7	17	2	16	20	53	80	84
Select 250ml/ha	2		3	2		4	43	43	19
Select 500ml/ha	-	0	0		2	2	-	-	19
Glean 20 g/ha	75	70	69	59	52	37	71	70	66
Intervix 600 ml/ha	nt	34	47	nt	36	26	nt	60	52
Glyphosate 1L/ha	-	0	0	-	0	4	0	16	27
Paraquat 1L/ha	-	-	-	-	-	-	-	-	7

Underlined numbers represent where sulfometuron was used instead of chlorsulfuron
nt = not tested

Resistance in wild oats

Wild oats were collected from 31 paddocks, almost all in the South East. Of these, Topik resistance was detected in 10% of paddocks, an unchanged result compared to the 2012 result where 10% of wild oats exhibited resistance to the Fop herbicide, Wildcat (Topik was not tested in 2012). No resistance to Atlantis or triallate was detected.

Table 3: Percent resistance in *Avena spp* (wild oats) 2012 and 2017 weed surveys. Populations were considered resistant if survival was ≥ 20% in outdoor pot trials conducted in the winter of 2017.

Wild Oats	2012	2017
Topik/ Wildcat	10	10
Atlantis	0	0
Triallate	0	0

Resistance in brome

Brome was most prevalent in both Mallee regions. Controlling brome with post-emergent herbicides in conventional wheat is only possible with one of three Group B herbicides, Atlantis, Crusader or Monza. Almost half the brome tested exhibited resistance to Atlantis and these would most certainly be cross-resistant to Crusader and Monza as previous studies have indicated. Fortunately, no cross-resistance to Intervix was observed. No resistance to Group A herbicides and glyphosate was detected indicating both herbicides are viable options for brome control.

Table 4: Percent resistance in brome (*B. diandrus*) collected in the 2007, 2012 and 2017 surveys. Populations were considered resistant if survival was ≥ 20% in outdoor pot trials conducted in the winter of 2017.

BROME	2007	2012	2017
Targa	0	0	0
Atlantis	33	51	48
Intervix	-	0	0
Glyphosate	-	-	0

A dash represents no testing with this herbicide.

Resistance in barley grass

Barley grass was only included in the latest survey therefore no data is available for 2007 or 2012. In 2017, 37 samples of barley grass were collected, almost all from the Mallee. The result was similar to brome, with resistance to Atlantis detected but not to Targa, Intervix or Glyphosate.

Table 5: Percent resistance of *Hordeum spp.* (barley grass) samples collected in 2017. Populations were considered resistant if survival was ≥ 20% in outdoor pot trials conducted in the winter of 2017.

Barley Grass	2017
Targa	0
Intervix	0
Atlantis	41
Glyphosate	0

Resistance in ryegrass has occurred at a greater rate than in brome, wild oats and barley grass. Reasons for this difference can be attributed to factors such as the genetics, incidence, frequency of resistance and seed production. Ryegrass is an obligate outcrossing species whereas the other three species are self-pollinating. Pollen mediated transfer of resistance therefore occurs more readily in ryegrass. Ryegrass is diploid whereas most other important grass species in winter cropping have greater ploidy levels. Expression of resistance is usually higher in diploid than in species with greater ploidy levels. Ryegrass seed yield is also usually greater than in brome, barley grass and wild oats. Another important difference is that ryegrass is more widely distributed than the other three species as identified in previous weed surveys. These features contribute to the complex herbicide resistance patterns that ryegrass exhibits and indicates why resistance to brome, barley grass and wild oats is less prevalent and develops at a slower rate. One interesting observation is although resistance to wheat selective Group B herbicides has been identified in barley grass and brome, no resistance to imidazolinone herbicides has been detected in any weed survey indicating that the frequency of resistance to imidazolinone herbicides lower compared to ryegrass.

Resistance in milkthistle/sowthistle (*Sonchus oleraceus*)

Milkthistle was identified in 118 paddocks throughout the survey zone in 2017, 58 from the South East and 60 from the Mallee. In the Mallee, over 90% were resistant to both Glean and Intervix, 3% resistant to 2,4-D. In the South East, about 70% resistance to Glean and Intervix was detected, while 24% exhibited resistance to 2,4-D. No resistance to glyphosate was detected in any sample. In contrast, one quarter of the samples exhibited resistance to 2,4-D in the South East. Resistance to Glean in both regions remained virtually unchanged between 2012 and 2017. Due to the strong cross-resistance between sulfonylurea and imidazolinone herbicides, control in Clearfield crops would be difficult with imidazolinone herbicides.

Table 6: Percent resistance in *Sonchus oleraceus* (sowthistle/ milkthistle) collected in 2012 and 2017 surveys. Populations were considered resistant if survival was ≥ 20% in outdoor pot trials.

Sowthistle	**2012**		**2017**	
	Mallee	**South East**	**Mallee**	**South East**
Glean	90	63	92	66
Intervix	-	-	91	76
2,4-D	-	-	3	25
Glyphosate	-	-	0	0

A dash '-'represents no testing with this herbicide.

Resistance in wild turnip (*Brassica tournefortii*)

Wild turnip was identified in 39 paddocks, almost exclusively from the northern Mallee region in 2017. Glean resistance was exhibited by 19% of samples and 16% exhibited resistance to Intervix. This is a reduction compared to the 2012 survey where over 30% of samples were Group B resistant. Availability of other mode of action herbicides is likely to have contributed to the reduction detected in 2017. Most Glean resistant samples were also cross-resistant to Intervix. As for sowthistle, the strong correlation between sulfonylurea and imidazolinone herbicides, will make control in Clearfield crops challenging. No resistance to other modes of action (2,4-D, Brodal and Atrazine) was detected.

Table 7: Percent resistance in *Brassica tournefortii* in the northern Mallee in 2017. Populations were considered resistant if survival was ≥ 20% in outdoor pot trials.

Wild Turnip	2012	2017
Glean	55	19
Intervix	33	16
2,4-D	0	0
Atrazine	-	0
Glyphosate	-	0

A dash '-'represents no testing with this herbicide.

Resistance in wild radish (*Raphanus raphanistrum*)

Wild radish was identified in 13 paddocks, almost exclusively in the South East. Glean resistance was detected in 46% of samples with 23% resistant to Intervix. Most samples resistant to Glean were also resistant to Intervix. 38% of the samples also exhibited resistance to 2,4-D with most also resistant to sulfonylureas suggesting multiple resistance. No resistance to glyphosate, diflufenican and atrazine was detected.

Table 8: Percent resistance in *Raphanus raphanistrum* in the South East in 2017. Populations were considered resistant if survival was ≥ 20% in outdoor pot trials.

Wild radish	2012	2017
Glean	0	46
Intervix	0	23
2,4-D	0	38
Atrazine	0	0
Brodal	0	0
Glyphosate	0	0

A dash '-'represents no testing with this herbicide.

Below is a section on soil carryover from Peter Boutsalis's talk at the last CSS meeting

Herbicide residues

- Key breakdown mechanisms for residual herbicides rely on:
  - microbial degradation
  - a chemical reaction known as hydrolysis.
  - Or BOTH
  - → Both mechanisms need soil water in same zone
- Insufficient rainfall, or rainfall followed by long dry spells → increase the duration of the required re-crop interval
- Herbicides broken down by hydrolysis include the triazines and sulfonylureas.
  - → Breakdown via hydrolysis is much slower at high pH levels
  - → Greater persistence in alkaline soils,
  - → microbial decomposition becomes the primary pathway for breakdown
- Imidazolinones are broken down primarily by microbial activity
  - → strong binding to soil in low pH conditions
  - → thus less available for microbial breakdown in low pH soils.
  - → longer persistence in low pH soils
- For highly soluble, low binding herbicides, leaching may be a major pathway for herbicide loss. If there is an impervious layer in the soil profile, herbicide may sit above this layer and therefore persist longer than in a free draining soil

Managing residues

- Mainly Group B residues
- Imazamox vs imazapic
- Clearfield CLR wheat, barley, canola, lentils
- Imazamox (in Intervix)/ Raptor
- Imazapic in OnDuty, Midas, Sentry (pre-em) for CLR crops, Flame (summer crops/ fallow)
- Raptor (imazamox) in peas, legume based pastures
- Imazapic has longer residual than imazamox
- Require extended moisture over summer to breakdown residues
- Consider growing CLR crop for residue management (no use of Group B in that year)

Key herbicide residues in the Mallee

	K_{oc}	DT_{50}
Imazapic (Flame®)	137= moderate = likely to move in soil water	= 232= Slow microbial degradation. Binding increases in acidic soils which increases persistence.
Clopyralid (Lontrel®)	5 = Very mobile	=40= Leaching can be significant. Microbial degradation, fastest in warm, moist soils
Triasulfuron (Logran®)	60= mobile	= 19 = Hydrolysis is the primary pathway in neutral and acidic soils. Slow microbial degradation is the primary pathway in alkaline soils

K_{oc} = indicator of binding to organic matter. Tight binding = slower to breakdown via either microbial or chemical degradation

DT_{50} = breakdown half life = indicator of persistence.
DT_{50} 0-30 = relatively non persistent, DT_{50} 30-100 = moderately persistent, DT_{50} >100 = persistent

Replanting intervals: Rainfall from time of application to to planting for Imazapic 525 + Imazapyr 175g/L

50-100 mm	100-150 mm	150-250 mm	more than 250 mm
Clearfield crops	**Crops in Column 1**	**Crops in Column 1&2**	**Crops in Columns 1-3**
Chickpea	Lentil	Biserrula	Barley
Clover	Lucerne	Lupins	Durum Wheat
Faba Bean	Medic		Triticale
Field Pea	Serradella		Wheat
	Vetch		

Cereal tolerance: wheat & triticale >> barley & durum wheat >> oats

http://www.herbiguide.com.au/Descriptions/hg_Imazapic_plus_Imazapyr.htm