5th South Australian Weeds Conference
PRC Auditorium and Meeting Rooms 1 and 2, Waite Campus, Adelaide
4th - 5th May 2016

PROGRAM
DAY ONE – WEDNESDAY 4TH MAY

Time	PRC Auditorium	Breakout Session Meeting Room
8.30	*Registration, coffee and tea*	
9.00	*Welcome and breakout sessions* – John Heap, WMSSA President	
	SESSION ONE - Chair: John Heap	
9.10	*Glyphosate, cancer and risk.* Ian Musgrave (Uni of Adelaide) Fiona Young (Flinders Uni) Q&A – Mediated by David Stephenson	
10.10	*What's happening at the national level in weed management?* John Virtue	
10.30	**MORNING TEA**	
	SESSION TWO - Chair: Peter Tucker	
11.00	*Support tools for making better investment decisions about early invaders.* Kate Blood and Bec James	*Herbicide Resistance: Herbicide groups, herbicide rotation, and resistance testing.* Peter Boutsalis
11.30	*Weed threats to South Australia's botanical-geographical regions.* Chris Brodie and Michelle Waycott	
12.00	*Open Source GIS is for everyone: Remote sensing of Coolatai grass infestations in Cobbler Creek Recreation Park.* Henry Rutherford	
12.20	**LUNCH**	
	SESSION THREE - Chair: John Virtue	
1.20	*Prickly pear cacti (opuntioid species group) biological control progress - post Weeds of National Significance (WoNS) coordinators.* Henry Rutherford	
1.40	*Gorse soft shoot moth – new bug on the block.* Sandy Cummings	
2.00	*Biocontrol of silverleaf nightshade.* Iggy Honan and John Heap	
2.20	*Water and infection effects of the native stem hemiparasite Cassytha pubescens on growth and physiology of the major invasive weed Ulex europaeus (gorse).* Robert M. Cirocco, Jennifer R. Watling and José M. Facelli	
2.40	**Regional-Roundup Part 1: AMLR; EP; AW; N&Y**	
3.20	**AFTERNOON TEA**	
	SESSION FOUR - Chair: Henry Rutherford	
4.00	*Changing people's behaviour for invasive species management; can community based social marketing help?* Leah Feuerherdt	*Preparing plant specimens.* Chris Brodie
4.20	*Pepper tree control in the Blinman area of the Flinders Ranges.* Paul Hodges	
4.40	*Good Ol' Olive debate, is your control as effective as it can be?* David Hughes	
5.00	*Day One Close*	
7.00	**DINNER – EDINBURGH HOTEL (need to pre-book a spot)**	

DAY TWO – THURSDAY 5TH MAY

Time	PRC Auditorium	Breakout Session Meeting Room
8.30	*Posters, displays, coffee and tea*	
9.00	*Welcome and WMSSA Website.* Leah Feuerherdt, WMSSA Vice President	
	SESSION FIVE - Chair: Nicole McGuiness	
9.10	*New technologies in agricultural weed control.* Sam Trengove	*Vertebrate Pest Update* Peter Bird
9.30	*Glyphosate resistance in non-cropping areas of Australia.* Jenna Malone, Anthony Cook, Hanwen Wu, Abul Hashem, Sarah Morran and Christopher Preston	
9.50	*Myrtle rust – a threat to native vegetation in South Australia.* Renate Velzeboer	
10.10	**Regional-Roundup Part 2: SAAL; SAMDB; SE; YP**	
10.50	**MORNING TEA**	
	SESSION SIX - Chair: Leah Feuerherdt	
11.20	*Non-chemical weed control.* Bob Curley	
11.40	*Roadside weed management in South Australia: Key issues and handy online resources.* Michaela Heinson and David Cooke	
12.10	*Weed management training opportunities.* David Georg	
12.30	*Some plants proposed for declaration under the NRM Act.* David Cooke	
12.50	**LUNCH**	
	SESSION SEVEN - Chair: Michaela Heinson	
1.50	*New tools for control of foxes and wild dogs in South Australia.* Peter Bird	*Training modules Subjects TBA* David Georg
2.10	*Watsonia control: Effectiveness of 2,2-DPA, impacts on native flora and influence of a prescribed burn.* Anthony Abley	
2.30	*Gazania species in vineyards.* Gereon Scnippenkoetter	
2.50	*Buffel grass update.* Troy Bowman	
3.20	*CLOSE AND THANK YOU FOR COMING!*	
3.30	**AFTERNOON TEA AND CHAT**	

Abstracts

Glyphosate, cancer and risk.

Ian Musgrave, Discipline of Pharmacology, University of Adelaide, Adelaide 5005.

Abstract. Glyphosate is the most used herbicide worldwide. Glyphosate targets the shikimic acid pathway which exists in plants and eubacteria but not animals, and thus has a very low acute toxicity in humans. However the chronic toxicity of glyphosate has been recently more controversial. Pesticides and herbicides are periodically re-evaluated as to safety. After several studies re-evaluating the safety of glyphosate, including the 2015 Federal Institute for Risk Assessment (BfR), suggested that glyphosate was neither mutagenic nor carcinogenic, the 2015 report by the International Agency for Research on Cancer (IARC) that classified glyphosate as class 2A, probably carcinogenic to humans, was a surprise to many international regulatory agencies. The subsequent 2015 European Food Safety Authority (EFSA) report that concluded that glyphosate was unlikely to pose a carcinogenic hazard did not end the concern over glyphosate.

Key differences between the IARC report and the EFSA report revolve around the breadth of evidence considered by the two groups, the weighting of human epidemiological studies, consideration of physiological plausibility and most importantly, risk assessment. The IARC does not take into account the risk the exposures will be likely to lead to cancer. Basic physiological plausibility for a carcinogenic effect is lacking, DNA damage is only seen at levels of glyphosate that cause non-specific damage. Animal studies are mostly negative, with no consistent, dose dependent carcinogenicity. Overall, there is no strong evidence that glyphosate is a significant cancer risk to humans. The recent Australian Pesticides and Veterinary Medicines Authority (APVMA) concluded that “based on current risk assessment the label instructions on all glyphosate products—when followed—provides adequate protection for users”

Glyphosate: IARC Monographs 2015, Volume 112-09
Conclusion on the peer review of the pesticide risk assessment of the active substance glyphosate: EFSA Journal 2015;13(11):4302
Australian Pesticides and Veterinary Medicines Authority: http://apvma.gov.au/node/13891

Effects of Glyphosate and Roundup on mammalian cells in vitro.

Fiona Young

Department of Medical Biotechnology, Flinders University, Adelaide, South Australia.

Abstract. The toxicity of the active molecule in herbicides has been used to determine regulatory guideline concentrations, because other components are considered inert. Glyphosate is the active molecule in the herbicide Roundup, and is soluble in water, but plant cell walls are comprised of hydrophobic molecules, hence Roundup additionally contains surfactant or other detergent-like molecules, which can pass through cell plant walls and effectively increase the herbicidal activity of glyphosate. Glyphosate interferes with a biochemical pathway that is only found in plants and not animals, hence in earlier tests glyphosate alone had little effect on mammalian cells and was judged to be safe.

In this research project, Roundup containing a known concentration of glyphosate was compared with the same concentration of pure glyphosate in mammalian cell culture systems that used human and mouse reproductive cells. Roundup was more toxic than glyphosate alone; when the human cells were cultured with the Roundup or the glyphosate for 24h, half the cells were killed by a 16mM concentration of glyphosate, but when the glyphosate was in the Roundup formulation, a much lower 0.008mM concentration of glyphosate killed half the cells.

The Australian Drinking Water Guideline for glyphosate is 1mg/L (0.006 mM) and is based on the premise that if an adult drank 2L of water containing 0.006mM glyphosate each day, there would be no adverse effects. The *in vitro* cell culture results cannot be directly extrapolated to *in vivo* effects, but they support the possibility that this Guideline is indeed safe for glyphosate alone. On the other hand, the cell culture results provide justification for environmental studies to investigate the degradation of Roundup, and animal studies to examine the toxicity and safety of the Roundup formulation.

In conclusion, Roundup was more cytotoxic than the same concentration of glyphosate alone, indicating that the other constituents of the herbicide are not inert. There is a need for *in vivo* studies to characterise the toxicity of glyphosate in a Roundup formulation, to facilitate re-evaluation of existing public health guidelines.

What's happening at the national level in weed management?

John Virtue, PIRSA Biosecurity SA, GPO Box 1671, Adelaide, SA 5001

Abstract. The Invasive Plants and Animals Committee (IPAC) was formed in late 2014 through an amalgamation of the Australian Weeds Committee and the Vertebrate Pests Committee. IPAC's scope includes terrestrial and aquatic weeds (including freshwater algae), as well as all vertebrates (excluding marine fish) and freshwater invertebrates. Regarding weeds, IPAC's "to do" list includes reviewing the Weeds of National Significance (WoNS) list, national research priorities and a revised national strategy. Progress on these has been pending National Biosecurity Committee (parent committee of IPAC) initiatives regarding the Established Pests and Diseases of National Significance Framework and completion of a national RD&E strategy for environmental and community biosecurity.

In the meantime Australian Government funding initiatives are providing opportunities to develop and increase the uptake of improved control techniques. Weed biological control has been given a substantial national boost with both a Meat and Livestock Australia (MLA) project and a Rural Industries Research and Development Corporation (RIRDC) project funded through the Rural R&D for Profit Program, covering seven WoNS. The Agricultural Competitiveness White Paper has allocated $50 million over four years to support farmers and the community to better manage common established pest animals and weeds. This includes allocated funding to states for education, extension and awareness projects. There is also $22m allocated nationally for development of new control tools and techniques.

At present there are two nationally cost-shared weed eradication programs – four tropical weeds and red witchweed, both in Queensland. Cost-sharing arrangements for eradication of exotic agricultural weed incursions are currently under development.

Support tools for making better investment decisions about early invaders

Kate Blood[1] and Bec James[2]

[1] Department of Environment, Land, Water and Planning, PO Box 7, Beaufort, Vic 3373, Australia

[2] Department of Environment, Land, Water and Planning, Private Bag 15, Ferntree Gully Delivery Centre, Vic 3156, Australia

Abstract. The Victorian Government has designed a package of tools to help public land managers to determine weed management priorities. A decision making framework, a series of six guides and the Victorian environmental weed risk database, guide land managers through a logical process to work out the highest priority early invaders to eradicate locally.

The Weeds at the Early Stage of Invasion (WESI) project focuses on high risk invasive plants that threaten biodiversity, but have not become locally abundant and widespread. We work with DELWP and Parks Victoria staff looking after public land anywhere in Victoria.

Each guide describes a different part of the decision making process so the land manager can either follow guides in their logical order or pick up the process relevant to their requirements. The guides contain optional templates that can be adapted for local use.

The package was developed based on scientific research and through the testing of various aspects during field-based pilots. The project team is supporting and building the capabilities of agency staff to use and implement the package.

Using the package will help land managers make better investment decisions for early invaders and assist with successful localised eradication of high risk weeds at the early stage of invasion. The tools are available at www.delwp.vic.gov.au/early-invaders

Weeds threats to South Australia's botanical-geographical regions

Chris Brodie and Michelle Waycott, State Herbarium of South Australia,
Adelaide Botanic Gardens, Hackney Rd, Adelaide

Abstract. The State Herbarium of South Australia (State Herbarium) is the key centre for knowledge and information on South Australia's native and naturalised plants, algae, fungi and lichens. Scientific verification of taxa is achieved through the lodgement of voucher specimens in the State Herbarium. Recognition of taxa new to South Australia requires this process to be completed and an entry to be made in the Census of South Australian Vascular Plants, Algae and Fungi, (Census) (http://flora.sa.gov.au/census.shtml). Currently the Census lists just over 5000 vascular plant taxa that grow wild in South Australia, of which almost one third, approximately 1,500, are classified as alien (non-native).

The State Herbarium separates the State into 13 botanical–geographical regions that vary in size and species richness. Comparisons of relative numbers of alien versus native taxa were made between the 13 regions. Large regions have the smallest percentage of known alien plants (5.9%) which are typically the more remote, arid regions of the state. In contrast, a large proportion of known alien taxa (up to 46.9%) are found in smaller regions which are typically more temperate, and have a greater number of people living in them or have major transport corridors.

The 'primary initial introduction pathways' for alien taxa is defined as the original cause or means of introduction to a region. We have investigated how alien taxa have been potentially introduced into South Australia's regions and their subsequent establishment by comparing, 'garden/planted', 'agricultural', 'both' or 'unknown' categories. We evaluated the primary initial invasion pathway for the smaller botanical regions by tabulating known sources of introductions. We found that the majority of taxa were derived from 'garden/planted' sources. In addition, the additional 21 taxa added to the declared list of South Australia's worst weeds (under the NRM ACT 2004), in July 2015, were also from 'garden/planted' sources. However, the 'primary initial introduction pathways' of alien taxa in larger remote botanical regions, were from 'agricultural' sources. We suggest future surveillance efforts appropriate to regional characteristics to facilitate better early detection of new weeds in the future.

Open Source GIS is for everyone: Remote sensing of Coolatai grass infestations in Cobbler Creek Recreation Park

Henry Rutherford
Department Environment Water and Natural Resources, Adelaide SA.

Abstract. The bush care community has long been recognised for putting in extraordinary efforts into weed control for the simple reward of contributing to the greater environmental good. Alongside the bush care community is a parallel community of open source developers working towards the goal of allowing computing access to all. One place where these two communities come together is through the Open Source Geospatial Foundation (OSGeo) - a not-for-profit organization dedicated to supporting freely released Geographical Information System (GIS) software. Where ‘free’ is as in ‘zero cost’, and ‘free’ is as in ‘empowered’ to access GIS in the same way a corporations, universities, or governments can.

This case study steps through: the South Australian Government’s commitment for spatial data to be freely accessible, and importantly avenues from where this data can be accessed; the process of accessing the GeoOS Linux distribution; and a wide range of freely published tutorials and guides to assist everyday practitioners to start on a Geographical Information Systems (GIS) journey. And the study project also demonstrates the use of the GeoOS distribution package for the semi-automatic classification of aerial imagery, to map changes in Coolatai grass infestations over temporal intervals within the Cobbler Creek Recreation Park.

Prickly pear cacti (opuntioid species group) biological control progress- post Weeds of National Significance (WoNS) coordinators

Henry Rutherford
Department Environment Water and Natural Resources, Adelaide SA.

Abstract. In recent years the family of prickly pear cacti (or opuntioid species group) have been centre stage as high risk, high priority weeds. Across Australia this has culminated in the listing of prickly pear cacti from the genera: *Opuntia, Cylindropuntia*, and *Austrocylindropuntia* as Weeds of National Significance (WoNS). A concerted effort from weed managers to collaborate both nationally and internationally has led to some fast-paced developments in the current best practice approach. In particular attention has been drawn to the understanding and sharing of biological control agents. New to Australia, and recently approved for release, is a distinct genetic biotype of the cochineal insect *Dactylopius tomentosus,* which is set to tackle coral cactus *Cylindropuntia fulgida* var. *mamillata*.

In 2015, for the first time for over 85 years, Australian entomologists returned from the Americas with 12 more genetic biotypes of the cochineal insect *D. tomentosus*. Of these, four biotypes are subject to application for release, and a further eight are under longer term evaluation. With all of these new insects at hand the future for cacti biocontrol in Australia has never looked brighter.

Gorse soft shoot moth – new bug on the block

Sandy Cummings
Natural Resources South Australian Murray-Darling Basin, DEWNR

Abstract. In a new initiative to assist landowners in their relentless battle against the invasive weed of national significance - gorse, NRM Officers Sandy Cummings and Scott Hutchens from Natural Resources South Australian Murray-Darling Basin travelled to Tasmania in early February 2016 to collect a new biological control agent - the Gorse Soft Shoot Moth *(Agonopterix umbellana)* - from nursery sites established in Tasmania.

The project involved working in collaboration with other interstate agency biocontrol experts Paul Sullivan, an Invasive Species Officer from NSW DPI and Dr John Ireson, an honorary research fellow from the University of Tasmania and Tasmanian Institute of Agriculture.

More than 1650 adult moths were successfully collected, with 650 moths released into NSW and 1000 moths brought back and released into South Australia.

Natural Resources SAMDB also worked together with officers from the Adelaide Mount Lofty Ranges region achieving six releases on suitable sites with two in the AMLR Region at Woodside and Parawa and four in the SAMDB Region at Palmer, Brukunga, Hope Forest and Mosquito Hill.

The Gorse Soft Shoot Moth was first released in Tasmania in 2007 following extensive testing to ensure that it only feeds on gorse. Since their release the insects have established well, particularly in the Tasmanian midlands which has a similar climate to the Adelaide Hills. The moth's larvae have the greatest impact, feeding on the new shoots and spines of gorse which results in the prevention or reduction of flowering and subsequent seed set.

The Gorse Soft Shoot Moth will complement the three other bio-control agents; the gorse seed weevil, the gorse spider mite and the gorse thrips that have been released for the biological control of gorse in Australia. NRM Officers will continue to monitor the establishment of the newly released bio-control agents and are planning to undertake additional releases to accelerate their spread.

Biocontrol of silverleaf nightshade

John Heap, PIRSA Biosecurity SA, GPO Box 1671, Adelaide, SA 5001
Iggy Honan, Natural Resources Eyre Peninsula, PO Box 37 Cleve SA 5640

Abstract. *Leptinotarsa texana* (silverleaf nightshade leaf beetle) was released about 22 years ago in South Africa to control the invasive perennial weed silverleaf nightshade (*Solanum elaeagnifolium* - SLN). The project was very successful, and SLN continues to be suppressed at much lower than original levels. A series of funding grant applications since 1999 in Australia finally yielded success in 2015 when a Federal Government grant was made to Meat and Livestock Australia (MLA) to engage researchers in SA, Vic and NSW.

A project is now underway to import and evaluate the beetles for potential release in Australia. The project will undertake: specificity testing of *L. texana* for a list of Australian test plants under quarantine; genetic studies to further define the origin of Australian SLN; climate matching studies to assess regions of Argentina and Chile as sources for *L. texana*. The first consignment of 152 live beetles from South Africa arrived in Melbourne in April, 2016. Host specificity testing in quarantine facilities will commence soon.

In January 2016, a field visit was undertaken by Iggy Honan to observe *L. texana* on SLN at a range of sites in South Africa. Observations and comparisons on South Africa’s soils, climate and farming systems compared to those in various parts of Australia will be discussed. The consensus amongst South African scientists and SLN managers in South Africa is that *L. texana* has an excellent chance of success in Australia, if approved for release.

Water and infection effects of the native stem hemiparasite *Cassytha pubescens* on growth and physiology of the major invasive weed Ulex europaeus (gorse).

Robert M. Cirocco, Jennifer R. Watling and José M. Facelli, University of Adelaide

Abstract. Weeds cost Australians around four billion dollars annually in addition to incalculable costs to biodiversity. Native parasitic plants may have detrimental effects on performance of invasive weedy hosts by removing resources via suckers and thus contribute to their demise. Glasshouse studies have documented severe effects of parasites on invasive species, but the effects of parasites may be highly variable depending on environmental conditions. We conducted growth and physiological measurements to investigate the effects of the native parasitic vine *Cassytha pubescens* on the major invasive weed *Ulex europaeus* (gorse) under high versus low water supply in the glasshouse. The native parasite had a strong effect on growth of gorse which was more severe in the well-watered treatment. This increased effect under high water supply may be due to improved parasite performance in these conditions. *Cassytha pubescens* also negatively affected the nitrogen-status of gorse and there was also evidence of breakdown in the photosynthetic apparatus of the host in response to infection. The data indicate that the native parasite negatively affects photosynthetic performance and growth of gorse by removing large amounts of nitrogen from the host. Thus, *C. pubescens* continues to show promise as an effective native bio-control against major invasive weeds of Australia, particularly in areas of high water availability and if successful, may be used to help restore our native biodiversity.

Full published paper, see:

Cirocco RM, Facelli JM, Watling JR. (2015). High water availability increases the negative impact of a native hemiparasite on its non-native host. Journal of Experimental Botany, pg 548.

Changing people's behaviour for invasive species management; can community based social marketing help?

Leah Feuerherdt, Rural Solutions SA

Abstract. As invasive species practitioners we are all involved in one form or another, working with landholders and community to reduce the impacts and distribution of pest species. To do this effectively we need behaviour change from our communities.

A common component of many of our programs focuses on increasing awareness amongst the community. Information campaigns often assume increasing knowledge will lead to a change in behaviour - if people understand how a weed impacts the environment or agriculture then they'll do what they can to help, right? Or sometimes we recognise that people might not care enough even with increased understanding so we focus on an economic self-interest approach. If people realise the financial impacts to their situation, that will be the incentive needed to change their behaviour. However, studies have shown that information/ education on its own has very little likelihood of changing behaviour.

Why don't these approaches work? And what can we do to achieve the behaviour change we seek? This presentation will address these questions and provide an introduction into the emerging field of community based social marketing.

Pepper tree control in the Blinman area of the Flinders Ranges

Paul Hodges, SA Arid Lands NRM

Abstract. Blinman has a significant pepper tree problem with hundreds of trees crowding the drainage line from the top of the catchment on Angorichina Station, 2km north of the town, through the Blinman Historic Mine site and through the town. The Blinman Progress Association has been seeking to have the trees removed for over 10 years now. Initially, the group had trouble convincing the community of the value of this project. However, over time, attitudes in the town have changed, culminating in the Pepper Tree Control project going ahead.

In March 2016 we engaged a team of three contractors for eight days to cut and swab pepper trees. They began at the top of the catchment, on Angorichina Station, and finished at the entrance to the Blinman Historic Mine. They removed 145 large pepper trees during this time. The Progress Association didn't want to simply burn the removed trees and decided that the trees should be mulched and stored in a disused dam for future use. So every tree that was removed was mulched (except for the large trunk material). The mulch will remain in the disused dam until the seed is no longer viable and the community will then be able to use the mulch in town landscaping projects.

We have funding to continue this project for another two years. Natural Resources SA Arid Lands have agreed to fund some native saplings to help initiate a revegetation program. The Blinman Progress Association has agreed to plant and maintain these trees that, over time, will provide habitat for native birds and animals and retain the aesthetic value of the town. They have also agreed to remove any pepper tree seedlings as they emerge.

Good Ol' Olive debate, is your control as effective as it can be?

David Hughes[1], G Donovan[2], V Clayton[1]
[1] Natural Resources Adelaide and Mount Lofty Ranges, Gawler, South Australia
[2]Donovans Earthcare, Kapunda, South Australia

Abstract. The wild *Olea europaea* ssp. *europaea* is distributed across southern Australia in clusters, mainly around Perth, Adelaide, Melbourne and Sydney, where it was planted as a fruit tree that has now naturalised as an invasive bushland weed. The control of wild olives is difficult and can require large inputs of resources. If you are paying contractors to control wild olives by a method such as drill and fill, or doing it yourself, it may be time to consider a different method. Basal bark treatment of wild olive has been used with great success in the North Para region of SA since 2007. A 2015 trial to compare overall cost for the treatment of mature wild olives using basal bark and drill and fill treatments was conducted. Fourteen mature trees were treated, firstly with basal bark treatment, and a week later a different crew drilled and filled the same trees.

The basal bark treatment showed clear benefits: no need to clear the ground of debris, lower branches or hazardous objects, saving time and cost; the reach of the spray wand eliminates the need to trim olive branches; work is mainly from an upright standing position, rather than crouched or kneeling; and labour efficiencies of basal bark treatment resulted in a $356 cost, compared to $2913 for drill and fill.

Multiple treatments can be required with the basal bark treatment in order to deliver enough chemical mixture to larger trees. Consequently operators do need to be skilled to ensure effective application. However other treatment methods often will require repeat treatment for regrowth. YouTube Video: https://www.youtube.com/watch?v=5-N_4qUVJ9w&list=PL4IsUu0-il4r9zQUTaGefpZOso1GPTIct&index=2

New technologies in agricultural weed control

Sam Trengove, Trengove Consulting, South Australia

Abstract. Automated weed control is rapidly developing around the world, in response to economic and environmental pressures. A number of robotic systems have been trialled in Australia. Precision Weed Management aims to direct treatments to only the areas where they are needed. For example, GPS-guided automated machinery can use a weed map of a paddock to apply herbicides only to known weed patches, thus saving on herbicide costs.

A company in Queensland, SwanFarm Robotics, has teamed with Westpac Agribusiness to develop agricultural robots that aim to control weeds autonomously. In other systems, weeds are sensed and sprayed automatically in the same pass.

This paper will review the field of automated weed control, and discuss current and future innovations for weed control in Australia.

Glyphosate resistance in non-cropping areas of Australia

Jenna Malone, Anthony Cook, [1]Hanwen Wu, Abul Hashem, Sarah Morran and Christopher Preston
University of Adelaide; [1]E.H. Graham Centre, Wagga Wagga, NSW

Abstract. Glyphosate is the most widely used herbicide for weed control in Australia, in both agricultural and non-agricultural situations. The first glyphosate resistant weed population in Australia was confirmed in 1996 in rigid ryegrass. Since then, resistance has been found in a growing number of other weed species.

Glyphosate resistant populations of rigid ryegrass have been identified from a variety of different agricultural situations, such as winter grain crops, chemical fallows, orchards and vineyards, while resistance in the other weed species has occurred mainly in chemical fallows. Resistance has also begun to appear in a number of non-agricultural settings including fence lines, roadsides, railways and irrigations channels. In a survey of non-agricultural areas likely to be of high risk of glyphosate resistance conducted across Australia, more than 50% of 82 hairy fleabane samples, 53% of 188 rigid ryegrass samples and 2% of 151 windmill grass contained high numbers of glyphosate resistant individuals. As resistance in these non-crop areas has the potential to spread into other areas and cause management difficulties elsewhere, this large amount of resistance identified suggests the need for increased focus on management in these areas.

A trial of alternate herbicides for roadside management in South Australia identified a mixture of amitrole and Basta to be the most viable option. A possible strategy for future management would be to continue to use glyphosate during the early winter period to control growth of susceptible weeds and thin out the weeds, followed in spring with an application of amitrole + Basta to control any weeds that had survived glyphosate application earlier in the year.

Myrtle rust – a threat to native vegetation in South Australia

Renate M.A. Velzeboer
Ecologist Marine Interactions and Wildlife Biosecurity
Department of Environment, Water and Natural Resources
renate.velzeboer@sa.gov.au

Abstract. Myrtle rust is an introduced disease affecting a wide range of plant species in the Myrtaceae family. It is considered to be established in New South Wales, Queensland and Victoria and has been detected in Tasmania and the Northern Territory. Eradication has been deemed unfeasible at the national level. Myrtle Rust is not known to be present in South Australia, but it is assumed that Myrtle Rust will eventually be detected in South Australia because spores are spread by the wind. It poses a future risk to a range of native plant species and ecosystems in South Australia. Climate modelling has indicated that the higher rainfall coastal areas of South Australia are at risk of Myrtle Rust infestation, namely the South East, Kangaroo Island, Fleurieu Peninsula, lower Yorke Peninsula and lower Eyre Peninsula.

Myrtle rust affects plants in the Myrtaceae family, the dominant plant family in South Australia. It is expected that disease caused by Myrtle Rust will rise and fall depending on environmental conditions and affect plants for three to four years out of a decade. Introduction of Myrtle rust into South Australia may significantly impact on native forests, parks and gardens, nurseries and Eucalypt plantations; with indirect impacts on native fauna, water quality and human lifestyles. It may reduce the genetic diversity and regeneration of seedlings in highly susceptible plant species and alter the composition and function of native vegetation communities.

To ensure a coordinated response for the management of Myrtle Rust in South Australia, Primary Industries and Regions South Australia (PIRSA), the Department of Environment, Water and Natural Resources (DEWNR) and private sector stakeholders are working together to regulate the movement of Myrtle rust host produce into South Australia, maximise the chances of early detection and prepare for the arrival of Myrtle rust. All suspected Myrtle rust infestations must be reported to the Exotic Plant Pest Hotline on 1800 084 881.

Chemical-Free Weed Control – Push for the Alternatives

Bob Curley, Balanced Habitats, South Australia

Abstract. Balanced Habitats was established in April 2004. The business is a Landscape Architectural Practice working specifically in Conservation-based projects in the Southern Metro' and Fleurieu regions of SA. Current clients include state and local Government agencies, NHT, volunteer groups and private landowners. Affiliations include representation for Industry on TAFE Weed Control and Conservation and Land Management Advisory Boards at TAFESA Urrbrae Campus, specifically regarding course study and licencing content. Currently we employ eight staff.

We have significant experience and training in a range of weed control strategies, techniques and programs. This experience has guided the business directions. We undertake a variety of different weed control strategies for our clients, many of which we will look at in this presentation. While we do utilise chemical applications where necessary, chemical free weed control is identified in Balanced Habitats Environmental Policy as our preferred method of control. We will always try to promote chemical-free strategies such as grubbing, slashing, hand-pulling, solarisation, de-heading, mass planting and bio-control. This is a conversation everyone in the Industry needs to have.

Roadside weed management in South Australia: Key issues and handy online resources

Michaela Heinson and David Cooke
Biosecurity SA and Natural Resources Adelaide and Mount Lofty Ranges

Abstract. Roadsides provide unique habitats for weeds due to frequent disturbances, water run-off, altered soil chemistry from road materials, and higher risks of introducing plant materials from transport and maintenance activities. Programs to control weeds on roadsides have strategic objectives which include: mitigating the threats posed by the dispersal of weeds to primary production, the environment and public health and safety; maximising visibility and public safety for road users; reducing fire hazard; and protecting biodiversity including native vegetation.

Through the development of a discussion paper, experts from local government, NRM organisations, state agencies and non-government organisations have identified key issues to be included in a proposed manual for roadside weed management. Contributors have clarified interactions between the implementation of the *Natural Resources Management Act 2004*, the *Local Government Act 1999*, the *Development Act 1993*, the *Fire and Emergency Services Act 2005* and other relevant legislation. Other issues for inclusion in the proposed manual are: clarifying roles and responsibilities for improved coordination; communication amongst stakeholders; herbicide resistance; and safe working procedures.

In this presentation online resources will be appraised with a view to improve the planning and delivery of roadside weed management programs. Relevant resources range from maps of state-managed roads to a report on roadside fuel reduction to guidelines for developing a weed hygiene plan.

Weed management training opportunities

David Georg, Smith & Georg

Abstract. Weed management training opportunities and resources in South Australia are discussed. Smith & Georg offers the nationally-accredited "Control Weeds" course *online*. For more information go to www.smithandgeorg.com.au/product/control-weeds

Completing both of Smith & Georg's "Chemical Accreditation" and "Control Weeds" courses meets the training requirements for licensing of weed control spray contractors in all states except WA. For information about training, accreditation and licensing requirements in each state go to www.smithandgeorg.com.au/articles/chemical-accreditation-state-by-state

All nationally-recognised training in Australia fits into the Australian Qualifications Framework (AQF). For more information about the AQF go to www.aqf.edu.au/aqf/in-detail/aqf-qualifications/

A searchable list of accredited training can be found at www.training.gov.au

An internet search for "weed management training australia" yielded several promising sites for formal training. An internet search for "integrated weed management" produced a long list of sources of information and opportunities for informal training.

Some plants proposed for declaration under the NRM Act

David Cooke, Biosecurity SA, GPO Box 1671, Adelaide, SA 5001

Abstract. Some weeds are declared in South Australia under the Natural Resources Management Act because they pose a risk to primary industries, natural environments or public safety. Declaration empowers NRM authorities to undertake programs that reduce future impacts and control costs by limiting the establishment and spread of these weeds, but necessarily imposes an additional cost on the community for each weed declared. The current review of declarations has provided an opportunity to maximise benefits from investment in weed control by land owners and government agencies.

In the fourth phase of the review, five more environmental weeds have been proposed by NRM Boards for declaration. These are:

1. alisma (*Alisma lanceolatum*) is an emergent water plant with large broad leaves and herbaceous flowering stems from a short underwater rhizome. It can be mistaken for a native *Alisma* species found in the same areas that has been known as *A. plantago-aquatica* but may be an undescribed species.

2. coastal tea-tree (*Leptospermum laevigatum*) from eastern Australia is an invader of near-coastal native vegetation. It's hard to get used to it being a foreign plant in this State, although even back home it is an invasive native. In places like Wilsons Promontory it is notorious for encroaching into heath on acid soils from its original home on neighbouring stabilised calcarenite dunes. Often this happens when burning has raised the pH of the heathland soils. It does similar incursions in SA into various coastal and near-coastal vegetation from sites where it has been planted, and could be confused with native Myrtaceae such as *Leptospermum coriaceum* (green tea-tree).

3. dune onionweed (*Trachyandra divaricata*) is a sandbinding perennial of coastal front dunes, introduced to South Australia from southern Africa. It spreads by seed when dry plants break off and are rolled along beaches by the wind. It can be toxic to livestock, causing photosensitisation.

4. giant reed (*Arundo donax*) is a large perennial grass of stream edges and wetlands, native to Eurasia. It resembles the common reed *Phragmites australis* but is a larger plant. Giant reed is sterile but vegetative propagation occurs when stems or rhizomes are moved deliberately, in soil or garden waste. It could grow along streams and in wetlands in the southern parts of South Australia. It tolerates a broad range of conditions and climates in areas that receive over 300 mm rainfall per annum.

5. parrot feather (*Myriophyllum aquaticum*) is a submerged aquatic plant introduced for use in ponds and aquaria. It interferes with flow of water in streams, recreational freshwater fishing and use of rivers for recreation; and competes with native aquatic plants for habitat. Parrot feather resembles some native *Myriophyllum* species such as *M. crispatum* and *M. verrucosum*.

New tools for control of foxes and wild dogs in South Australia

Peter Bird, Biosecurity SA, Box 1671, Adelaide, SA, 5001
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Abstract. The Canid Pest Ejector (CPE) is a device for delivering a toxic dose of 1080 to foxes and wild dogs. It uses a spring-activated piston to propel the poison contents of a capsule into the mouth of a canid when it pulls on a baited lure head. The Nationally registered 1080 capsules used in the device are now available in South Australia. CPEs have several advantages over conventional meat baits. They are only activated by animals exerting >1.6 kg pull strength; they cannot be moved; they have reduced distance restrictions from habitation; the capsules retain their full toxic dose; and they require less frequent checking. Off-setting this, CPEs are expensive and their persistent toxicity offers a different risk profile to domestic dogs.

PAPP (Para-aminopropiophenone) is the long-awaited toxic alternative to 1080 for use in fox and wild dog baits. PAPP baits will be available imminently as the ACTA manufactured bait products FOXECUTE® and DOGABAIT®. PAPP works by preventing oxygen transport, has few symptoms and is painless. Unlike 1080, PAPP has a highly effective antidote but needs to be administered by a vet which limits its usefulness in protecting domestic dogs. On the down side PAPP baits will be considerably more expensive than equivalent 1080 baits, are only available in manufactured form, and have some off-target concerns.

These two new tools will complement the use of 1080 baits, especially in peri-urban areas and for long-term control programs, but neither is likely to overthrow 1080 baiting as the pre-eminent control for foxes and wild dogs in South Australia.

Watsonia control: Effectiveness of 2,2-DPA, impacts on native flora and influence of a prescribed burn.

Anthony Abley
Department of Environment, Water and Natural Resources, Adelaide, SA

Abstract. Across the Mount Lofty Ranges, bulbil watsonia *Watsonia meriana var. meriana* has naturalised and poses a significant threat to bushland and wetland areas. Where watsonia invades native vegetation, it tends to form dense monocultures displacing native herbs, grasses and other understorey species. The optimal time for herbicide control is when the parent corm has been fully exhausted but before the daughter corm has fully developed. This is just as the flowering spikes appear in spring. This is also the time when most components of the native flora are actively growing and so a herbicide that is highly selective for bulbil watsonia in native vegetation is required. A study conducted in south-west Western Australia (Brown *et* al, 2008) suggests that the herbicide 2,2-DPA (Propon®) has suitable selectivity. A recent trial in the Adelaide Hills tested the effectiveness of 2,2DPA, its impacts on the flora of stringybark woodland, where bulbil watsonia poses a significant threat, and tested the use of fire as a post-herbicide regeneration tool.

Gazania species in vineyards

Gereon Scnippenkoetter, Nufarm Australia Limited

Abstract. Gazania species have emerged as dominant weeds in vineyards in the Riverland region of SA. Growers have experienced variable and unreliable control of this weed with herbicide applications. The presentation explores the herbicide options and spray timings in vineyards to effectively control this weed. Results from replicated field trial sites conducted 2012-2015 in Loxton and Renmark are presented.

Weedmaster Duo (360g/L glyphosate) at 4.5L/ha -9L/ha with the addition of Pulse applied early in July provided good effective control of Gazania sp. compared to later applications in August. Applications a month later in August provided poor results. This variability of control is likely due to dry conditions that prevailed. The pre-emergence herbicide Terrain (500g/kg flumioxazin) appears to control this weed effectively with four month residual activity.

Where are we now and where to from here?

Troy Bowman, Biosecurity SA, PO Box 1671, Adelaide, SA 5001
troy.bowman@sa.gov.au

Abstract. Buffel grass has been recognised as one of the greatest threats to biodiversity in South Australia's arid and semi-arid rangelands. It has the capacity to transform ecosystems through habitat loss, competition with native plants and alteration of natural fire regimes.

A three year project funded through the Native Vegetation Council's significant environmental benefit program, has been successful in implementing a range of buffel grass management activities to aid strategic management and build the capacity of communities.

Project activities include targeted surveillance and control, strategic response activities, herbicide trials, landholder workshops and development of extension materials on best practice vehicle hygiene, identification and control.

In partnership with a variety of stakeholders, significant strategic control efforts have taken place to establish roadside containment lines, and target isolated outliers and priority source infestations. With approximately six months left in the current buffel grass project, the future in buffel grass management lies with NRM authorities, regional councils, DPTI, rail corridor managers, private landholders and community groups to take it to the next level.

Weeds at the Early Stage of Invasion (WESI) Project

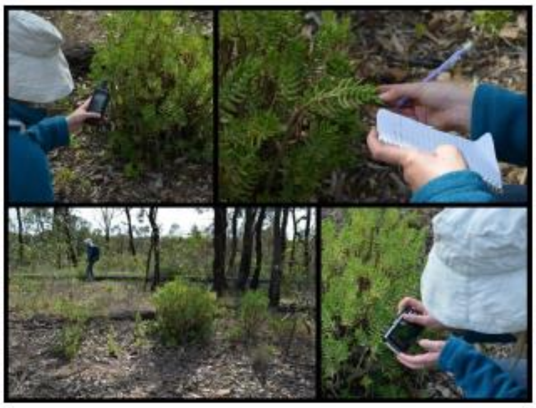
Overview

The Weeds at the Early Stage of Invasion (WESI) project focuses on high risk early invaders that threaten biodiversity. We work with Department of Environment, Land, Water and Planning (DELWP) and Parks Victoria staff looking after public land anywhere in Victoria.

By investigating the barriers that prevent action on early invaders, WESI has created a process and tools to assist public land managers.

The WESI project's framework leads public land managers through a decision making process, this is supported by a set of detailed guides available at www.delwp.vic.gov.au/early-invaders

These help answer questions such as: I found a new plant in my park, what do I do? Is this early invader in my reserve a high risk? How do I work out how far this early invader has spread? How do I prepare an eradication response plan?



A number of steps undertaken when searching for and detecting potential early invaders.

WESI project focus

The focus of the WESI project is enabling the early intervention and localised eradication of high risk invasive weed species on public land in Victoria at any scale. It aims to support, enable and build the capabilities of DELWP and Parks Victoria staff working on early invaders that threaten biodiversity.

Pilot projects

The project team have set up a series of pilot projects to assist adoption of the WESI process and tools by local public land managers. It also provides an opportunity to test and refine the tools out in the field with real life scenarios.

Buffel grass (*Cenchrus ciliaris*) pilot in the Mallee.

WESI is resourced by DELWP's Weeds & Pests on Public Land program and compliments Statewide biosecurity protection of agricultural assets and eradication at a Statewide scale.

Contact the project team:

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22 April 2016

VICTORIA State Government | Environment, Land, Water and Planning

Testing Weeds for Herbicide Resistance

Dr Peter Boutsalis
The University of Adelaide & Plant Science Consulting,
Waite Institute, Glen Osmond, SA 5064
www.plantscienceconsulting.com.au

Following a herbicide failure, a herbicide resistance test can identify if resistance was responsible. A herbicide resistance test can optimize weed control by identifying which herbicides are effective and which ones are not. Assuming a weed population is resistant when it isn't can result in over-reliance on more expensive herbicides and unnecessary selection pressure that may lead to resistance to these also. Plant Science Consulting offers two resistance tests, a SEED TEST and a whole plant QUICK-TEST.

What is a SEED TEST: a seed test utilizes seeds from mature plants that are tested.
What is a QUICK-TEST: a Quick-Test involves collecting healthy plants growing in the field for testing.

The availability of two tests provides the opportunity to test at different times of the year. Plant Science Consulting has been offering both tests for almost 15 years. Below is an example of a results table presented in a typical herbicide resistance report. More information is available at www.plantscienceconsulting.com.au.

Table 1: Results from a herbicide resistance test conducted for a grower by Plant Science Consulting. Ryegrass was collected from a fenceline following a herbicide failure. The data is presented as percent survival. Additionally, a resistance rating (see photo below) provides information on the level of resistance of surviving plants; R= weak, RR= intermediate and RRR= strong resistance, S= no resistance detected. The results indicate that 60% of the plants exhibited intermediate resistance to 1.5L/ha glyphosate and 15% exhibited weak resistance to 3L/ha. Paraquat was totally effective.

Herbicide	Product Rate (L/ha)	Herbicide Group	Survival (%)	Resistance Rating
Glyphosate 540	1.5	M	60	RR
Glyphosate 540	3	M	15	S
Paraquat	1.5	L	0	S

Resistance rating. Left to right: RRR, RR, R	Tillering plants growing in a crop can be used for Quick-Test
	

Germinating ryegrass seedlings can be used for a Quick-Test	Young broadleaf weeds can also be used for a Quick-Test
	

Using the Quick test to confirm Glyphosate resistance in brome from a fenceline	How much ryegrass seed to collect for a seed test.
	

INTERVIEW WITH A RESEARCHER - 2014

RESEARCH FUNDED BY NATURE FOUNDATION SA

RESEARCHER: MR ROBERT CIROCCO, UNIVERSITY OF ADELAIDE PHD STUDENT
RESEARCH PROJECT:"THE EFFECT OF *CASSYTHA PUBESCENS* ON *ULEX EUROPAEUS* ALONG AN ENVIRONMENTAL STRESS GRADIENT IN THE MT. LOFTY RANGES OF SOUTH AUSTRALIA.
SUPERVISOR: A/PROFESSOR JENNIFER WATLING

C. pubescens infection front on *U.europaeus* at Crafers
Photo: Robert Cirocco

What was the aim and purpose of your project?

Parasitic plants feed off other plants via suckers. *Cassytha pubescens* is a parasitic plant that is native to Australia and attaches to the stems of its hosts. The parasitic vine infects both invasive and native hosts, but invasive hosts seem to suffer much more from infection. Thus C. *pubescens* shows potential as a native bio-control agent against major invasive weeds of Australia. But more research is needed so informed decisions can be made about the true potential of this parasite as an effective management tool in helping control these invasive weeds. Here, the main aim was to investigate the effect of C. *pubescens* on the physiology of Ulex *europaeus*, a Weed of National Significance (WoNS) in Australia. This assessment was conducted at three field sites in the Mt Lofty Ranges which varied in both slope and aspect.

Summarise the results of your project.

Although the field sites varied in slope and aspect it appears that infection duration was a more important factor that influenced the effect of the parasite in this host. *C. pubescens* negatively affected the physiology of U. *europaeus* mainly at two of the three field sites where plants had been infected the longest. Infection with C. *pubescens* results in U. *europaeus* becoming water and nitrogen stressed and having lower rates of photosynthesis which would translate to less carbonhydrate available for growth. These results revealed that C. *pubescens* can negatively affect the physiology of U. *europaeus* in the field.

The data provides further evidence that *C.pubescens* may be successful in helping control major invasive weeds of Australia such as U. *europaeus* which cost millions of dollars annually to eradicate and reduces our native biodiversity.

What is the most exciting thing about this work?

- Working on a plant that latches on to other plants with suckers and removes water and nutrients so it can grow at the expense of the host.
- Working on plant associations that occur in remnant vegetation.
- My work can help make informed decisions about using a native parasitic plant as a novel bio-control agent against major invasive weeds of Australia.
- Using physiological measurements to help understand how this native parasite affects host plant processes such as photosynthesis.
- Using a combination of glasshouse and field studies to help evaluate the associations between C. pubescens and its invasive and native hosts.

" The most exciting thing about conducting this study was working out in the field (including before dawn) and quantifying the effect s of C. *pubescens* on U. *europaeus* in a natural setting"

Vigorous growth of C. *pubescens* on *U. europaeus* in the glasshouse
Photo: Robert Cirocco

Pepper tree control in the Blinman area of the Flinders Ranges.

Paul Hodges, DEWNR, SA

Background

The Blinman Copper Mine was established in 1862 and closed in 1918. At its peak, between 1903 and 1918, the population of Blinman was around 2000 people. Whilst the exact time of the introduction of pepper trees to Blinman is unknown, nursery catalogues in Adelaide first advertised pepper trees for sale between 1870 and 1880. Another clue to when pepper trees first arrived in Blinman comes from the fact that many Cornish miners in Burra relocated to Blinman at the height of the copper mine's activity. Pepper trees were introduced to Burra by the Cornish miners and it is feasible they took seed with them when they went to Blinman. So it is quite likely that pepper trees have been in Blinman for over 100 years.

Pepper trees were popular with early European settlers in Blinman because they grew quickly, were drought tolerant, provided a good source of firewood, offered abundant shade, and possibly with the additional advantage as a natural repellent to flies. Many of the native trees were used as supports within the mine structure, fuel to fire the copper smelters and as firewood to keep people warm during the cold winters. Supplies of native trees would have dwindled quickly, once production was in full swing. The people would have learnt quickly that eucalypts were relatively slow growing and they needed a tree that grew quickly. Pepper trees fitted their needs and were grown out of necessity.

However, once the mine closed and the miners moved away, pepper trees were no longer utilised. Their suitability to the location, that had once been an asset to the mine, now allowed them to thrive unchecked.

Current situation

Whilst it is likely that pepper trees have been in Blinman for over 100 years, they would have initially been grown in and near the township of Blinman. However, over time they have successfully spread 50km down the length of the drainage line to Commodore Swamp and on surrounding slopes. They have also been spread by birds, with emu scats full of pepper tree seeds a common sight in the area.

The Blinman Mine site and Blinman township now have particularly large pepper tree infestations. Over time, as the pepper trees grew, native vegetation retreated as a result of the allelopathic properties of the pepper trees and their fast growth and thick canopy that prevented light reaching the native plants. Pepper trees now form the dominant over-storey in this area.

Chris Reynolds, land manager of Commodore Station (25km SW of Blinman), undertook pepper tree control in and around Commodore Swamp about 5 years ago. He considered them a pest and wanted to remove them. However, ongoing reinfestation occurred because the source of the infestation had never been addressed.

Blinman is near the top of the catchment that flows into the Parachilna Creek and then into Commodore Swamp. This means that to achieve removal of pepper trees from the drainage system, starting at the top of the catchment is a logical choice.

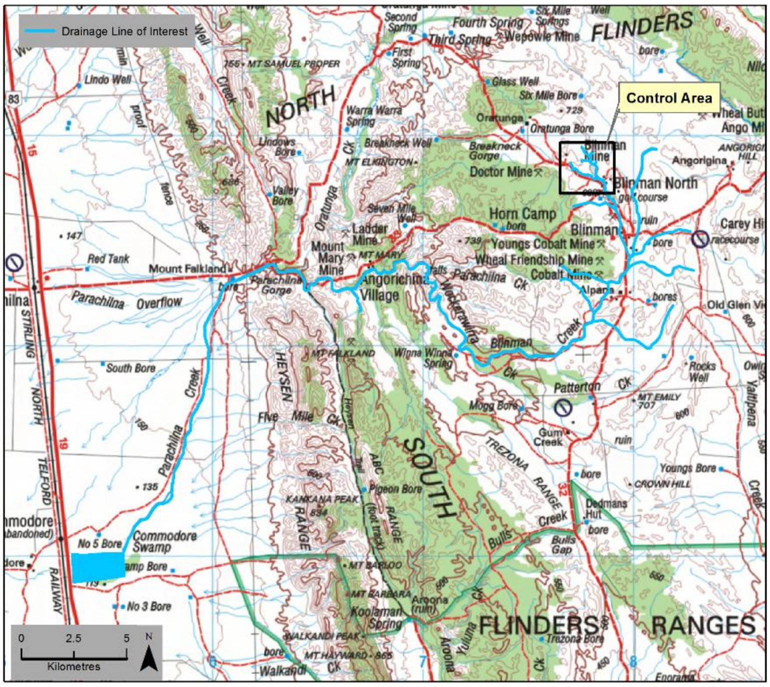

Figure 1 - Parachilna Creek and tributaries map

Community involvement

The Blinman Progress Association mooted the removal of pepper trees in Blinman about 10 years ago. The idea of removing the pepper trees alarmed some members of the community who believed:

- Pepper tree removal would make the town look bare,
- There would be no shade,
- Pepper trees were part of the local landscape,
- Habitat for native birds would be lost,
- Privacy of some homes within Blinman would be lost.

Another issue was the town's main tourist attraction, the Heritage Copper Mine, valued a grove of pepper trees near the mine entrance that provided shade for tourists prior to tours. The residents wanted these trees to remain.

The Progress Association worked with the community on solutions to these issues. They educated the community about the fact that pepper trees weren't native to Blinman (or even Australia) and that they were an invasive weed that had resulted in the lack of regeneration of endemic native trees and shrubs over the past 100 years.

They also worked with the community on planting native tree seedlings 10 years ago, that would grow and allow the removal of pepper trees at a later time. Therefore, plans were in place to ensure that the aesthetic value of the town, shade and habitat were not compromised, with the future removal of pepper trees.

These efforts culminated in the town deciding last year that pepper tree control could commence in the creek line and in public areas in the town. The Mine site was also approved for removal of pepper trees, however, the grove near the mine entrance has been exempted until an alternative source of shade can be arranged. The Progress Association is seeking alternative funding to build an all-weather shelter outside the mine entrance. A few landholders decided that they wish to retain pepper trees in their gardens, which are not in or

near the creek line. This agreement has allowed the initial pepper tree removal to begin in the priority areas.

Strategy

The North Flinders Natural Resource Management Group (NRM) had listed pepper trees as a priority pest plant when they developed their District Weed Strategy. The Blinman Progress Association had previously discussed their interest in pepper tree control at Blinman with the NRM Group and how they were willing to support it. When the NRM Group were discussing potential projects for the 2015/16 year, they identified pepper tree control at Blinman as a priority.

The SA Arid Lands NRM Board agreed to fund the commencement of works on pepper tree control in 2015/16. The Board acknowledged that this project would require more work to remove pepper trees from Blinman, so committed to replicate this funding for a further two years, starting from the top of the catchment and working down.

The preferred method of removal was discussed with the Progress Association. The Progress Association didn't want trees treated and left *in situ*, as they believed this would allow trees to disperse seed as they died, and dead trees would not be attractive in the landscape. They wanted the trees removed and utilised, rather than simply burnt. It was decided that the trees would be mulched and the mulch would be stockpiled at a disused dam nearby. The mulch would be kept until the seed was no longer viable after three years and then used on town landscaping projects.

Ongoing management of the project site was identified as being important to prevent reinfestation. The Progress Association has committed to removing any new pepper tree seedlings that emerge in the project area from seed already present including seedlings that emerge at the mulch stockpile site. This will need to continue until all the pepper trees from the township are finally removed.

Implementation

Prior to works starting, a representative of the Heritage Mine site marked trees not to be removed (e.g. grove near mine entrance) and areas of the mine that were no-go zones for safety reasons (e.g. old mine shafts).

Works began on Angorichina Station, at the top of the catchment, continued through the mine site and finished at the entrance to the Mine. One hundred and forty five large pepper trees were removed from an area of approximately one square km.

The contractors used a cut and swab method. As many of the trees were very large, the chainsaw operator cut each tree down and frilled the stump, then a spray operator applied the *Access®* and diesel mix within seconds of frilling, to ensure the stump would not regrow.

The branches were all fed through a 300 mm mulcher into the back of a high-sided truck with canopy. This system was very effective, with only the large trunk material not being able to fit in the mulcher. This was also time efficient, reducing travel time to the dump site, as it took a lot more trees mulched to fill the back of the truck than if they had been loaded as whole branches.

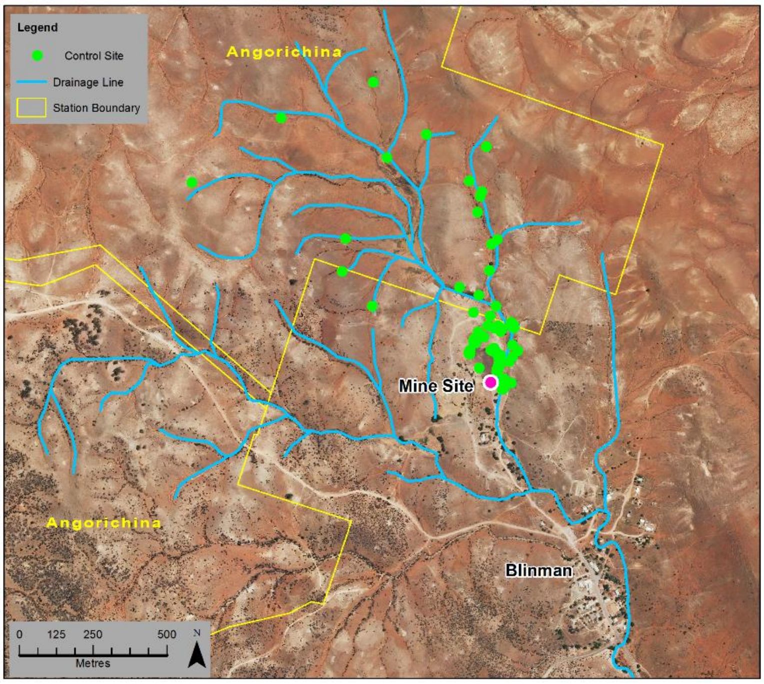

Figure 2 – Blinman Pepper Tree Control (March 2016)

What next

The Blinman Progress Association will monitor the works and mulch stockpile sites and remove pepper tree seedlings as they emerge.

The SA Arid Lands NRM Board have been researching native trees endemic to Blinman and will discuss with the Blinman Progress Association which species could be included in a revegetation project that will complement the plantings the Progress Association have already done. The NRM Board will provide plants and tree-guards to the Progress Association to help replace the trees removed. The Progress Association will do the planting, erect the tree-guards, water and maintain. As seedlings will need to be grown specifically for this project, from local provenance seed, it is likely the revegetation will occur after April 2017.

The SA Arid Lands NRM Board will liaise with the Blinman Progress Association on the timing of the next stage of the project. The Blinman Progress Association will report the success of the project to the North Flinders NRM Group. This community prompted weed program will assist in guiding how the NRM Group decide on future strategic pest plant priorities and programs.

Good Ol' Olive debate, is your control as effective as it can be?

D Hughes[1], G Donovan[2], T Brookman[1], V Clayton[1]
[1] Natural Resources Adelaide and Mount Lofty Ranges, Gawler, South Australia [2]Donovans Earthcare, Kapunda, South Australia

Background

The wild *Olea europaea ssp. europaea* is distributed across southern Australia in clusters mainly from the cities Perth, Adelaide, Melbourne and Sydney where it was planted as a fruit tree that has now naturalised as an invasive bushland weed (Richardson (2011)). The control of wild olives is difficult and can require large inputs of resources (APCC (1999)).

Introduction

If you are paying contractors to control wild olives by a method such as drill and fill, or doing it yourself, it may be time to consider a different method. Basal bark treatment of wild olive has been used with great success in the North Para region since 2007. A 2015 trial to compare overall cost for the treatment of mature wild olives using basal bark and drill and fill treatments was conducted. Fourteen mature trees were treated firstly with basal bark treatment and a week later a different crew drilled and filled the same trees.

Method and trial overview

Cost effectiveness of basal bark vs. drill and fill.
PURPOSE: To determine the overall cost for the treatment of mature wild olives, using two different techniques, and the cost effectiveness of olive control.
This cost is inclusive of labour, chemical and machinery.

- Blind trial
- Fourteen trees treated - approximately 3m in height

The trial didn't measure the efficacy of the treatment. But anecdotally the treatment is proving to be effective.

	CHEMICAL	METHOD
Basal Bark Method	Triclopyr 30ml/ 1L Bio Oil	Apply using knapsack sprayer
Drill & Fill	Glyphosate 360gm/L at 30% mixed with water and 1ml enviro dye per litre of chemical mixture	Using 12mm drill bit around the lignotuber at a distance no more than 20mm apart

Basal Bark: No marker used so that the next team cannot see that previous control has occurred on this site. Chemical applied to fully cover the stem from tuber to a height dependent on the height of the tree. Several re-treatments may be required as bark absorbs chemical mixture.

Drill and fill: Drill holes all the way around the olive tree and within the olive tree forks if required. Fill drill holes immediately with chemical after drilling.

Results
Important to note basal bark took 3.5hrs and drill and fill took 44.5hrs.

Basal bark treatment:
Includes:
- Two operators
- Labour: total 3.5 hours
- Herbicide: Bio safe & Garlon mix - 30 litres = $130.50
- Work Zone Traffic Management: 1 day @$40.00 per day

TOTAL COST: $356.00

One operator could carry out work, but it was done by two people. Work as a single operator avoided cramping the other operator.
Sprayer: Croplands Swissmex 5 litre (solvent resistant rubber parts).
No need to clear the ground of debris, lower branches or hazardous objects.
The length of reach into the olive tree using the wand and arm of operator eliminates the need to trim olives. Much more mobile over the uneven ground with work mainly in upright position, not consistently crouched or on knees.

Drill and fill treatment:
Includes:
- Two operators
- Labour: Total 44.5 hours
- Herbicide: Water & Glyphosate mix - 45 litres = $135.00
- Work Zone Traffic Management: 3 days @$40.00 per day = $120
  Site clean-up of off cut olive branches = $300

TOTAL COST: $2,913.00

Two operators used. Three days, with weekend break between and operators rotated with one experienced operator always present. Used Stihl two-stroke power drill matched with four, 12mm x 270mm, auger bits. Need to clear lower branches and debris to remove woody barriers to access the lignotuber and lower part of the trunk. Need to check for hazardous objects and insects. Direction needed on disposal of tree trimmings. Added cost to dispose of these was $300.
Posture of operators is usually on knees or crouching. Need to brush away wood sawdust from holes. Variation in hardness of olive trees sometimes required great force and the auger bits occasionally jammed in tree. Two bits were broken (not included in costing). Drill bits eventually need sharpening or replacement. With low revs on drill the spark arrestor had to be cleaned. Set up and removal of Work Zone Traffic Management required each day.

Key messages about basal bark treatment:
1. It is all about the operator (getting enough chemical in to kill the lignotuber). Operator will greatly reduce possible off target damage through patience in application and belief in technique.

2. Not for all situations but does cover a lot of broad situations. In high value native vegetation use drill and fill if damage from basal likely.

Discussion

In this trial the cost of drill and fill was eight times that of basal bark treatment. In a recent trial at SA Water Little Para Reservoir in March 2016 the result was about four times, due to site factors associated with steeper terrain, denser olive infestation and larger olives treated by basal treatment area than drill and fill.

The basal bark treatment showed clear benefits:

- No need to clear the ground of debris, lower branches or hazardous objects, saving time and cost.
- The reach of the spray wand eliminates the need to trim olive branches.
- Work is mainly from an upright standing position, rather than crouched or kneeling.
- Labour efficiencies of basal bark treatment resulted in a $356 cost, compared to $2913 for drill and fill.

Multiple treatments can be required with the basal bark treatment in order to deliver enough chemical mixture to larger trees. Consequently operators do need to be skilled to ensure effective application. However other treatment methods often will also require repeat treatment for regrowth.

YouTube Video
https://www.youtube.com/watch?v=5-N_4qUVJ9w&list=PL4IsUu0-il4r9zQUTaGefpZOso1GPTIct&index=2

References:

Animal and Plant Control Commission South Australia (1999) "Weed risk assessment and management of olives" (APCC, Adelaide).

Richardson F.J. (2011) "Weeds of south-east - an identification guide for Australia" (F.J. Richardson, R.G. Richardson, R.C.H Shepherd).

Glyphosate resistance in non-cropping areas of Australia

Jenna Malone, Anthony Cook, Hanwen Wu, Abul Hashem,
Sarah Morran and Christopher Preston

Background

Glyphosate is the most widely used herbicide for weed control in Australia, in both agricultural and non-agricultural situations. While glyphosate resistance has occurred at numerous sites in agricultural systems in Australia, it has also begun to appear in a number of non-agricultural settings including road sides, railway rights-of-way and irrigation channels. Glyphosate resistance in these non-crop areas, in addition to causing immediate impacts, has the ability to spread into other areas and cause management difficulties elsewhere. Herbicide resistance in non-agricultural situations has not been reported often and little is known about the risks of herbicide resistance evolving in these areas.

Glyphosate resistant weeds occur in patches on road sides where glyphosate is the only weed management strategy used. Left: glyphosate resistant annual ryegrass in a ditch along a road. Right: glyphosate resistant windmill grass on the edge of a roadside.

Resistance Survey

A physical survey of areas likely to be at high risk of glyphosate resistance was conducted across Australia to obtain a better understanding of the extent of glyphosate resistance in non-cropping areas. Surveys were conducted in Western Australia, South Australia, Victoria, New South Wales and Queensland and involved driving along major roads and highways and collecting weed species present on the roadsides, along railway right-of-ways and around buildings or irrigation channels. Four different weed species were targeted in the survey: annual ryegrass (*Lolium rigidum*), fleabane (*Conyza bonariensis*), windmill grass (*Chloris truncata*), and barnyard grass (*Echinochloa colona*).

More than 400 samples of whole plants or seed of the four species were collected from SA, NSW, QLD, VIC and WA. Resistance was identified in all four weed species. High frequencies of glyphosate resistance were identified in annual ryegrass and fleabane, where more than 50% of populations contained high numbers of resistant individuals. Resistance was identified in all states surveyed.

Glyphosate resistance was found to occur in all non-agricultural areas surveyed. Roadsides, often adjacent to crops, were where a majority of the resistant samples were from. However, resistance was also identified along irrigation channels, railway rights-of-way and around buildings, such as silos.

Resistant populations of all species targets were identified, with over 50% of ryegrass and fleabane populations containing resistance. Over 30% of the barnyard grass populations contained resistance, however sample number was low. Windmill grass was the only species to have a low level of resistance with only 7% of the populations tested containing resistance.

Summary of the location and number of populations collected, and number of qlyphosate resistant populations for each species collected from the non-cropping area survey.

Species	Location	No. collected/ No. resistant	Total	Resistant (%)
L. rigidum	NSW	75/37	186	50%
	SA	54/41		
	WA	57/15		
C. bonariensis	QLD	9/7	84	52%
	NSW	41/31		
	VIC	14/0		
	SA	12/6		
	WA	8/0		
E. colona	QLD	1/1	9	33%
	NSW	8/2		
C. truncata	Vic	65/6	150	7%
	WA	22/1		
	SA	6/0		
	NSW	55/1		
	QLD	2/0		


Fleabane populations sprayed with glyphosate showing susceptible and resistant individuals

The roadside survey demonstrated that there is a large amount of glyphosate resistant weeds in non-cropping areas. These resistant weeds need to be controlled by other weed management techniques. Glyphosate resistant weeds evolve wherever there is intensive reliance on glyphosate for weed control and few or no other weed management practices used. Glyphosate resistant weeds in non-agricultural areas have the potential to spread into nearby agricultural production areas and vice versa. Effective management of glyphosate resistant weeds in non-agricultural areas will reduce this risk.

Alternate herbicides trial

To quantify the performance of alternative herbicides to glyphosate on roadsides in South Australia, three areas of roadside at which glyphosate resistance was common, as identified in the above survey, were treated with alternate herbicides.

The sites were located along the Princes Highway at Millicent, Blyth to Halbury Road at Blyth and Main South Road at Aldinga. Seven treatments included glyphosate (Roundup, Weedmaster Duo, Ken-up Gold), amitrole, glufosinate (Basta), sulfometuron-methyl and carfentrazone-ethyl (Hammer) in various mixtures, and treatments differed slightly between sites. Each site comprised 7 km of roadside on both sides of the road. Treatments were

applied by the Department of Planning, Transport and Infrastructure (DPTI) contractor for the area and each treatment was applied to 1 km on each side of the road. Assessments were made at two and four weeks after application as % brownout and at twelve weeks as % growth reduction.

Results

- Glyphosate provided good control of all weeds, except where glyphosate resistant ryegrass was present and, despite the presence of resistance at all sites, remained among the most effective herbicide treatments.
- Sulfometuron-methyl performed poorly at all locations. Much of the ryegrass in cropped areas of South Australia is resistant to sulfometuron-methyl and it is likely that this has moved onto roadsides.
- Amitrole was generally effective on broadleaf weeds, but less effective on grasses. Two rates were used and the higher rate was not more effective than the lower rate.
- Basta performance was variable. There was a rapid effect at burndown, but at Millicent, where grass populations were higher, Basta was less effective. Basta performed poorly on broadleaf weeds at Millicent and at Blyth.
- The mixture of Basta plus Hammer was similar to Basta at all sites, except that Hammer improved broadleaf weed control at Millicent. At other sites, the poor performance of this mixture may have been caused by some antagonism on grasses leading to lower control.
- The mixture of Basta plus Amitrole performed well at all sites. Where grass growth was particularly thick not all the grass was controlled. This mixture performed better where weed populations were lower. It was particularly good at Blyth due to the lower density of grasses compared with Millicent and Aldinga.

Effect of Basta plus Amitrole treatments four weeks after application at Millicent (top), Aldinga (middle) and Blyth (bottom).
Prior to treatment on left, after treatment on right.

Recommendation 1

- Sulfometuron-methyl, amitrole and Basta applied alone were not sufficiently effective to be recommended as a replacement for glyphosate.

Recommendation 2

- The only treatment that could be recommended as a replacement for glyphosate was the mixture of amitrole and Basta.

A possible strategy for the future would be to continue to use glyphosate during the early winter period to control growth of susceptible weeds and thin out the weeds. This could be followed in spring with an application of amitrole + Basta to control any weeds that had survived glyphosate application earlier in the year.

Any strategy that relies on a single herbicide or herbicide mixture to control weeds is likely to fail due to resistance. Annual ryegrass has already evolved resistance to amitrole when used on railway lines, road sides and in vineyards. It is likely that annual ryegrass may evolve resistance to the mixture of amitrole + Basta in the future. To reduce the risk of resistance occurring, alternative practices that control the weeds should be used where practical.

Chemical-free Weed Control – Push for the Alternatives

Bob Curley, Balanced Habitats, South Australia

Theme – **This involves everyone -** Native habitats, agricultural lands, urban landscapes and back yards all require weed control – all these environs can benefit through weed removal without chemical applications – so can we.

Message – "**Pay the Money, Make it Pay**"- a problem is land manager perceptions and expectations (whether private or public land managers). The universal agreement, physical removal WORKS – always more than one option.

Objectives – **audience** will understand some **alternatives** to chemical applications for weed control. **Weed controllers** will consider **alternatives** to chemical applications for weed control. **Land Managers** will undertake weed programs identifying chemical-free strategies.

Conclusion

"Stop Right There, Stop Right Now" –Chemical control is causing multiple issues of its own which we do/will have to deal with – we need to stop doing what we are now before we can change what we are doing - make a decision to use alternative techniques – always push the chem'-free options – change attitudes i.e. of Contractors and Project Officers.

Balanced Habitats – Small Business - Bob Curley (Proprietor) - BLArch/PGDipDesign Adelaide Uni, DAppSc UniSA (Wildlife and park management)

Balanced Habitats was established in April 2004. The business is a Landscape Architectural Practice working specifically in Conservation-based projects in the Southern Metro' and Fleurieu regions of SA. Current clients include state and local Government agencies, NHT, volunteer groups and private landowners. Affiliations include representation for Industry on TAFE Weed Control and Conservation and Land Management Advisory Boards at TAFESA Urrbrae Campus, specifically regarding course study and licencing content. Currently we employ eight staff.

We have significant experience and training in a range of weed control strategies, techniques and programs. This experience has guided the business directions. We undertake a variety of different weed control strategies for our clients, many of which we will look at in this presentation. While we do utilise chemical applications where necessary, chemical free weed control is identified in Balanced Habitats Environmental Policy as our preferred method of control. We will always try to promote chemical-free strategies such as grubbing, slashing, hand-pulling, solarisation, de-heading, mass planting and bio-control. This is a conversation everyone in the Industry needs to have.

New tools for control of foxes and wild dogs in South Australia

Peter Bird, Biosecurity SA

Canid Pest Ejectors

The Canid Pest Ejector (CPE), formerly known as the Mechanical Ejector or M44, is a device for delivering a toxic dose to foxes and wild dogs (pest canids). It uses a spring-activated piston to propel the poison contents of a capsule into the mouth of a canid when it pulls on a baited lure head with a force of more than 1.6 kg.

CPEs have been used for coyotes in the US since the 1930s. Following extensive testing in Australia by the Invasive Animals CRC, the 1080 capsules used in the device were recently registered Nationally by the APVMA. CPEs units are now available in South Australia – the units from Animal Control Technologies Australia and the 1080 capsules from local Natural Resources authorised officers who have been trained in their use.

CPE's have a range of advantages and disadvantages over conventional meat baits:

Advantages:

- more target specific; only activated by large animals with sufficient pull strength
- cannot be moved (eg. cached by foxes) meaning a lesser risk to domestic dogs
- reduced distance restrictions from habitation (150 m) offers greater peri-urban facility
- full toxic dose maintained, unlike baits, which quickly lose toxicity over time
- lure head above ground; locatable and attractive for longer than buried baits
- reduced requirement for checking and replacement (2-4 months)
- interchangeable bait head lures can be used to target different individuals
- controls bait-shy individuals that cache but do not eat baits
- used as sentinels to supplement long-term baiting control programs
- quickly de-activated / re-activated as required

Disadvantages

- expensive initial purchase (~$70) + bait head and capsule
  - persistent toxicity means potential greater risk to domestic dogs in longer term
  - may be less attractive than baits to some individual animals
  - exposed bait head susceptible to ants and birds
  - toxic capsules contain high concentration of 1080 which could be misused

While baiting is likely to continue as the main technique for canid control, CPEs offer another tool for landholders to protect livestock and wildlife. They will be especially useful where risks to domestic dogs are high, and to complement long-term baiting programs.

PAPP – an alternative to 1080

Para-aminopropiophenone (or 'PAPP') is the long-awaited active ingredient in poison baits soon to be released for control of foxes and wild dogs in Australia. The baits have been developed over the past decade by the Invasive Animals CRC and will be available commercially through Animal Control Technologies Australia as the manufactured bait products FOXECUTE® and DOGABAIT®. The question on most people's lips is: 'How will these new baits compare with the existing 1080 bait products for fox and wild dog control?'

Advantages

- PAPP is demonstrably humane. Once absorbed into the bloodstream, PAPP works by converting normal haemoglobin in red blood cells to methaemoglobin, which prevents oxygen transport to tissues such as the heart and brain. This is known as metabolic anoxaemia and is painless. Affected animals become lethargic and sleepy, gradually losing consciousness with few obvious symptoms. A fox typically dies 1-2 hours after ingestion of a bait.
- **Unlike 1080, PAPP has an antidote.** Methylene blue converts methaemoglobin back to haemoglobin which rapidly reverses the effects of poisoning. There is no tissue or cell damage, meaning any animal given the antidote, or receiving a partial dose, recovers without ill effect within about 1 hour. Currently methylene blue can only be injected intravenously by a veterinarian. This severely limits its usefulness in saving poisoned domestic dogs, considering the quick time to death (45-90 mins) and lack of warning symptoms other than blue/grey colouration of the lips and tongue (cyanosis). Yellow plastic marker beads will be incorporated into PAPP baits to alert vets to the type of toxin, while red marker beads will to be used in ACTA 1080 baits.

Disadvantages

- PAPP baits will be considerably more expensive than equivalent 1080 baits, likely more than double the price. This is because PAPP is more costly to synthesize and requires much higher doses than 1080 (400-1000 mg of PAPP vs 3-6 mg of 1080). It has also been a long costly process to commercialise the new bait product.
- PAPP baits will only be available in manufactured form, not as an injectable, potentially limiting their palatability to some individual target animals.
- Dogs and foxes are more susceptible than most animals to PAPP but others, notably goannas, bandicoots and quolls, are quite sensitive. Design of baiting programs will need to take this into account by adjusting the timing, presentation and location of baits to minimize risks to off-target species.

The introduction of two new tools for pest canid control in South Australia will allow greater flexibility when delivering control programs. In particular, the two techniques potentially reduce the risk to domestic dogs, providing greater opportunity to target foxes in high-risk peri-urban environments. The new tools will complement the use of 1080 baits but neither is likely to overthrow 1080 baiting as the pre-eminent technique for fox and wild dog control in Australia.

Glyphosate, Cancer and Risk.

Ian Musgrave, Discipline of Pharmacology, University of Adelaide, Adelaide 5005

ABSTRACT:

Glyphosate is one of the most used herbicides worldwide. Glyphosate targets the shikimic acid pathway which exists in plants and eubacteria but not animals, and thus has a very low acute toxicity in humans. However the chronic toxicity of glyphosate has been recently more controversial. Pesticides and herbicides are periodically re-evaluated as to safety. After several studies re-evaluating the safety of glyphosate, including the 2015 Federal Institute for Risk Assessment (BfR), suggested that glyphosate was neither mutagenic nor carcinogenic, the 2015 report by the International Agency for Research on Cancer (IARC) as class 2A , probably carcinogenic to humans, was a surprise to many international regulatory agencies. The subsequent 2015 European Food Safety Authority (EFSA) report that concluded that glyphosate was unlikely to pose a carcinogenic hazard did not end the concern over glyphosate.

Key differences between the IARC report and the EFSA report revolve around the breadth of evidence considered by the two groups, the weighting of human epidemiological studies, consideration of physiological plausibility and most importantly, risk assessment. The IARC does not take into account the risk the exposures will be likely to lead to cancer. Basic physiological plausibility for a carcinogenic effect is lacking, DNA damage is only seen at levels of glyphosate that cause non-specific damage. Animal studies are mostly negative, with no consistent, dose dependent carcinogenicity. Overall, there is no strong evidence that glyphosate is a significant cancer risk to humans. The recent Australian Pesticides and Veterinary Medicines Authority (APVMA) concluded that "based on current risk assessment the label instructions on all glyphosate products—when followed—provides adequate protection for users":

INTRODUCTION:

Glyphosate (N-phosphonomethyl glycine; CAS registry #38641-94-0) is a broad-spectrum post-emergence herbicide used worldwide in agriculture, forestry, domestic and governmental settings for weed control. Since its introduction in 1974, its use has expanded significantly, particularly post – 1992, to become the one of the most used herbicide world-wide and has displaced other herbicides with unfavourable toxicity profiles such as alachlor and metolachlor.

As with all herbicides, glyphosate is subject to regulatory control in a variety of jurisdictions, especially with regard to human and environmental safety. This reviewed periodically. For example the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) evaluated glyphosate in 2003, 2006 and 2011 (JPMR 2011). The US EPA evaluated glyphosate in 1993 and re-evaluated it in 2013 (EPA, 2013). The Australian Pesticides and Veterinary Medicines Authority (APVMA) conducted a review in 2013 (APVMA, 2013). All these studies concluded that glyphosate was very safe on acute exposure, with very low toxicity. They also concluded that long term exposure unlikely to cause cancer in either animals or humans.

In 2015 the International Agency for Research on Cancer (IARC) classified glyphosate as class 2A , probably carcinogenic to humans (IARC 2015). They concluded that there was sufficient evidence of carcinogenicity in animals, and limited evidence of carcinogenicity in humans (IARC 2015). In the same year the European Food Safety Authority (EFSA) concluded that glyphosate was unlikely to pose a carcinogenic hazard to humans (EFSA, 2015). In many cases exactly the same information was used to assess the carcinogenic potential of glyphosate.

Assessment for potential carcinogenicity looks at several lines of evidence. The ability of a chemical to cause mutagenic changes in *in vitro* monitoring systems, the ability to cause cancer in animal species, and epidemiological evidence of cancer in exposed human populations. This paper will look at the differences in the breadth of evidence considered and the emphasis on that evidence in the IARC and EFSA evaluations, and its implications for operators.

GLYPHOSATE MECHANISM OF ACTION:

Glyphosate targets the shikimic acid pathway. This pathway is essential for the synthesis of a number of metabolites like folic acid and aromatic amino acids in plants, fungi, algae and eubacteria. However this pathway is not present in animals and mechanism based toxicity does not occur. Acute toxicity at high concentrations of glyphosate appears non-specific, and not relevant to cancer. Glyphosate is not an electrophile, so direct chemical toxicity is unlikely. There are some reports that glyphosate has weak estrogenic effects at high concentrations, however the EFSA's regulatory screening reported no estrogenic effects (EFSA, 2015; Greim et al., 2015).

MUTAGENESIS AND CARCINOGENESIS

One step in establishing whether a chemical can produce cancer in humans is to demonstrate a mechanism for the chemical to do so. Typical assays examine if the chemical causes mutations in bacteria, damage to DNA in mammalian cells or damage to the nuclear material.

It is of interest to compare a key review with the IARC and EFSA reports. The most recent review of these studies examined data from the peer-reviewed literature and data submitted to regulatory agencies on these assays (Kier and Kirkland, 2013). All 24 studies that looked at the ability of glyphosate to cause mutation in bacteria (technically, reversion assays) were negative. Three studies that looked at the ability of glyphosate to produce mutations in mammalian cell lines were also negative. Six studies that examined the ability of glyphosate to produce chromosomal aberrations were negative, while two studies from a single laboratory reported chromosomal aberrations with glyphosate, but these showed no consistent concentration response effect. Over all Kier and Kirkland (2013) concluded that the weight of evidence from both the *in vitro* and *in vivo* chromosomal effect assays indicated a lack of chromosomal effects.

Evidence that glyphosate can cause beaks in mammalian DNA is more equivocal, after reviewing available studies Kier and Kirkland (2013) point out that DNA damage is typically only seen at high concentrations that cause tissue toxicity, and DNA damage is likely to reflect cell death, rather than a mutagenic potential of glyphosate. Kier and Kirkland (2013) concluded that glyphosate did not represent a significant genotoxic risk.

In the IARC report (IARC 2015), the main emphasis is on the DNA damage results, and there was minimal consideration of the potential role of tissue toxicity confounding the interpretation, when the IARC came to the conclusion that there was strong evidence of genotoxicity. Whereas the EFSA considered the consistency and methodological quality of a broad range of genotoxic assays to conclude that there was no strong evidence of genotoxicity (EFSA 2015).

ANIMAL CARCINOGENICITY STUDIES:

Again, I will first consider a key review, which covers the majority of the studies considered by the IARC and the EFSA, then turn to the IARC and EFSA studies. Greim et al., (2015) reviewed the available animal carcinogenicity data covering nine rat studies and five mouse studies. The studies included studies reported to the regulatory authorities, and the majority were all considered high quality studies. Exposures were for at least 80% of the lifetime of the animals, and doses ranged up

to over 1 gram of glyphosate per kg animal weight in many studies. In rats there were no significant increases in any tumour type. In mice in one study increases were seen for hepatocellular adenoma and carcinoma in males, but not females, and no dose-response relationship was seem (ie. An increase in tumours was seen at a single low dose of glyphosate and not at higher doses). In one study bronchiolar-alveolar adenocarcinoma and malignant lymphoma was seen in males, but not females. Overall, the authors concluded that the carcinogenic potential of glyphosate was non-existent or extremely low in animal models up to very high doses (Greim et al., 2015).

The EFSA evaluated the nine rat studies and five mouse studies reported by Greim et al., (2015) and concurred with their conclusion that concluded that glyphosate was unlikely to pose a carcinogenic hazard to humans (EFSA, 2015). In contrast the IARC only evaluated six of the 9 rat studies and two of the five mouse studies. In one rat study a significant increase in adenocarcinoma was identified but this was not dose dependent. In one mouse study it found a positive trend in males for renal tubule adenomas and carcinomas (IARC 2015 cf the studies cited above).

Given the more limited data examined by the IARC, and the inconsistencies in animal response, the IARC conclusion of “sufficient evidence of carcinogenicity in animals” does not appear to be justified (However see Portier et al., 2016 for a dissenting view).

HUMAN EPIDEMIOLOGICAL CARCINOGENICITY STUDIES:

Two relevant peer reviewed papers will be considered when looking at the IARC and EFSA reports. Mink et al., (2012) reviewed all incidences of cancer reported in human studies up to 2011, while Chang and Delzell (2016) performed a systematic review of haematological malignancies. In evaluating cancer risk, several kinds of study are used. Case control; where patients who have cancer are compared with patients who do not have cancer, and risks are evaluated retrospectively and cohort; where people are followed before cancer has developed and cancer outcomes are related to the risk factors. As well, systematic reviews and meta-analyses of multiple studies can be performed to find trends that are not apparent from individual studies. Limitations of these studies include difficulties in estimating glyphosate exposure and confounding factors from other herbicides and pesticides and other cancer risks.

Mink et al., (2012) evaluated seven cohort studies and fourteen case control studies, they considered that the data did not support a causal association between glyphosate exposure and cancer. Thirty epidemiological studies were reported by the IARC (IARC 2015). Ten cohort studies and nine cohort studies showed now evidence of cancer associated with glyphosate use. In addition to these studies, a small number of cases suggested an increased risk of Non-Hodkin leukaemia (NHL; IARC 2015). The EFSA concluded that there was very limited evidence of an association between glyphosate exposure and the occurrence of NHL. Chang and Delzell (2016) performed a systematic review of haematological malignancies to address this issue, and an earlier systematic review which suggested a positive association. After careful analysis the authors concluded that no causal relationship was established between glyphosate exposure and haematological cancer risk (Chang and Delzell, 2016).

HUMAN EXPOSURE:

Absorption data for humans is limited, but overall the data suggest there is little absorption. Around 20% of an oral dose of glyphosate is absorbed and around 1% of glyphosate applied to the skin is absorbed (Greim et al., 2015; Neimann et al., 2015, IARC. 2015, EFSA, 2015). As well, glyphosate is rapidly excreted and is considered to have no or minimal bioaccumulation potential.

Studies of exposure to glyphosate in various groups all suggest that exposure is around two orders of magnitude below allowable daily intake (ADI), which has been set at 100 times lower than the no observed adverse effect level. Of relevance to workers involved in weed control, exposure levels have been estimated to be less than 1% of ADI (Neimann et al, 2015; EFSA, 205). In terms of the cancer studies, relevant exposures associate with positive findings in mice were on the order of 1g glyphosate/kg bodyweight per day, whereas worst case exposures of farm workers are around 0.004 mg/kg/ bodyweight per day. This provides a significant margin of safety, and occupational exposure is unlikely to be a significant health risk

CONCLUSION:

The IARC conclusion that glyphosate is a probable human carcinogen was arrived at using a narrower base of evidence than that from recent peer- reviewed papers and the EFSA's review. The IARC also does not significantly consider exposure risk, whereas the EFSA considers the risk from typical exposure levels and durations. Overall, considering the data presented in the per-reviewed literature, the IARC report and the EFSA report, there is no strong evidence that glyphosate is a significant cancer risk to humans. The recent Australian Pesticides and Veterinary Medicines Authority (APVMA) conclusion that "based on current risk assessment the label instructions on all glyphosate products—when followed—provides adequate protection for users" is warranted based on the available data.

REFERENCES:

IARC Working Group. Glyphosate. In: Some organophosphate insecticides and herbicides: diazinon, glyphosate, malathion, parathion, and tetrachlorvinphos. Vol 112. IARC Monogr Prog, 2015:1–92.

Conclusion on the peer review of the pesticide risk assessment of the active substance glyphosate: EFSA Journal 2015;13(11):4302

Australian Pesticides and Veterinary Medicines Authority 2013: http://apvma.gov.au/node/13891

http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/JMPR/Report11/Glyphosate.pdf

Chang ET, Delzell E. Systematic review and meta-analysis of glyphosate exposure and risk of lymphohematopoietic cancers. J Environ Sci Health B. 2016 Jun 2;51(6):402-34.

Greim H, Saltmiras D, Mostert V, Strupp C. Evaluation of carcinogenic potential of the herbicide glyphosate, drawing on tumor incidence data from fourteen chronic/carcinogenicity rodent studies. Crit Rev Toxicol. 2015 Mar;45(3):185-208.

Kier LD, Kirkland DJ. Review of genotoxicity studies of glyphosate and glyphosate-based formulations, Crit Rev Toxicol. 2013, 43:4, 283-315

Mink PJ, Mandel JS, Sceurman BK, Lundin JI. Epidemiologic studies of glyphosate and cancer: a review. Regul Toxicol Pharmacol. 2012 Aug;63(3):440-52.

Niemann L, Sieke C Pfeil R, Solecki R, A critical review of glyphosate findings in human urine samples and comparison with the exposure of operators and consumers. J Verbr Lebensm (2015) 10:3–12

Portier CJ, et al. Differences in the carcinogenic evaluation of glyphosate between the International Agency for Research on Cancer (IARC) and the European Food Safety Authority (EFSA). J Epidemiol Community Health. 2016 Mar 3. doi: 10.1136/jech-2015-207005. [Epub ahead of print]

New technology for improved herbicide use efficiency

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Keywords: weed identification, ryegrass, targeted application, herbicide efficiency

Take home messages

- Site specific herbicide application can optimise weed control while minimising herbicide cost.
- The economic return from SSWM with herbicides cannot exceed the cost of the highest cost herbicide applied unless the herbicide has a phytotoxic effect on the crop that reduces yield.
- High density weed patches should be targeted with high efficacy treatments over several years to deplete the seed bank.
- Next generation weed identification sensors are being investigated for use in Australia.

Background

Site specific weed management (SSWM) has the potential to deliver significant improvements in weed control efficiency, through the targeted application of weed control measures only to where the weeds are located. Improvements in weed control efficiency will typically be achieved through reduced herbicide usage where herbicide is not required. SSWM has four principal components

1. Weed identification: Locate and identify weeds.
2. Treatment decision: Make decision on appropriate treatment to control the weeds.
3. Application: Apply appropriate treatment to the weeds.
4. Documentation: Record weed location and as applied treatment.

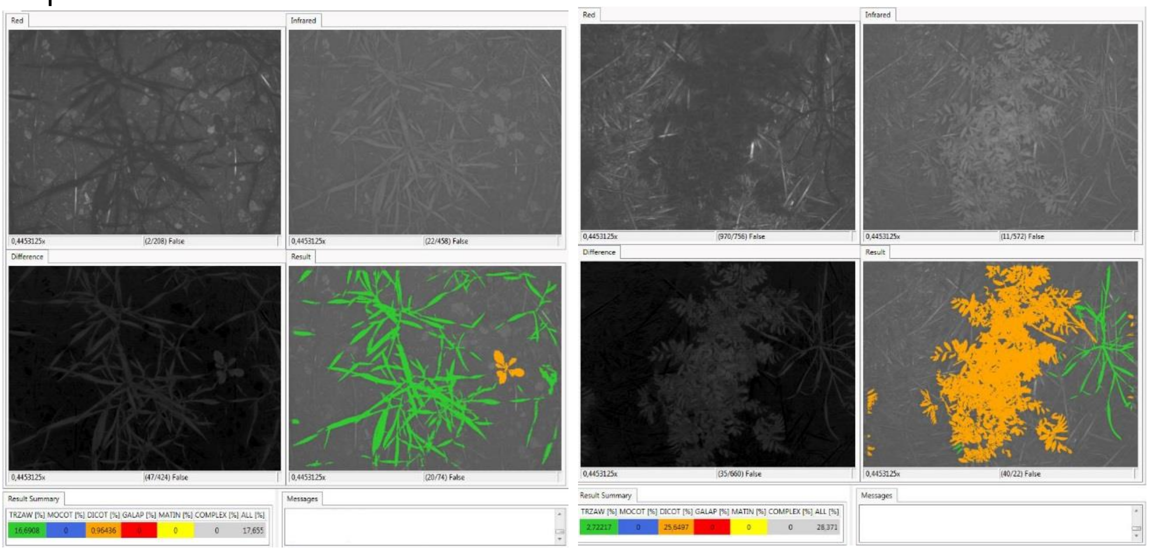
This presentation will discuss the current state of play for weed identification sensors and review recent results of site specific herbicide trials.

Weed Identification

Presently, the only commercial weed sensors are spot spray systems that are only for use in fallow situations, where all green plants are considered weeds and sprayed, such as the Weedseeker and WEEDit systems. However, numerous groups around the world have been working on sensing systems that can identify different weed species within a growing crop, including several groups in Australia, however there are no commercially available products yet.

Agricon is a precision ag company in Germany that is developing and commercialising a weed ID sensor for the European market. This sensor uses near infrared and red imagery and leaf shape parameters to differentiate different weed types from crops. SAGIT is funding a project led by SPAA (Society of Precision Agriculture Australia) to assess this weed ID sensor in Australian crops and to produce new adapted classifiers for identifying important Australian weeds in Australian crops. This includes all the grain legumes lentils, field peas, faba beans, chickpeas and lupins which are not typically grown in Germany. Examples will be presented.

Above: The H-Sensor mounted to the ute for mapping and collecting images of the crop and weeds.



Above Left: wheat and an indian hedge mustard collected in the red and near infrared spectrum, and how the sensor has classified these differently, right: lentil and ryegrass collected in the red and near infrared spectrum, and how the sensor has classified these differently.

Variable Rate Herbicide Application - Results

The economic return from SSWM with herbicides can't exceed the cost of the herbicide unless the herbicide has a phytotoxic effect on the crop that reduces yield. Therefore, when costs for weed mapping and variable rate application are considered, it is apparent that SSWM with low cost herbicides will not be economical.

Variable rate applications of pre-emergence herbicides in cereals are more economically viable, as these herbicides are typically more expensive. The herbicide savings are dependent on infestation level, but in one paddock where 35% of the paddock was infested

1. Variable rate application targeting Boxer Gold to the high density patch and trifluralin to the low density patch would have generated a saving of $15.30/ha.

2. Variable rate applications reduced the risk of low returns from using high cost herbicides across the whole paddock.

3. Variable rate application made it economic to treat smaller patches. To make an economic return in the year of application with a uniform high cost treatment (Boxer Gold in this paddock trial)required at least 11% of the paddock to have a high density ryegrass patch. With variable rate application it was economic to treat patches less than 6% of paddock area. This assumes $7.50/ha for uniform rate application costs and $15/ha for variable rate application costs.

Across a number of paddocks in the 'high' density weed patches the highest efficacy treatments were also generally higher cost, being greater than $25/ha in all cases. In high weed densities these higher costs were returned through increased yields. The exception being where the herbicides caused phytotoxic effects on the crop. The benefit of high efficacy treatments at high density weed sites was often observed in subsequent years with reduced seedling recruitment in following years, but due to the high background seed bank associated with the high density patches the populations were still elevated and required ongoing targeted management with high efficacy treatments to deplete the seed bank further. Where herbicide application was reduced at low density weed sites it was important to continue monitoring these sites for any population increase in subsequent seasons and treat where necessary. Improved weed detection systems will facilitate annual surveillance of weed patches and their change over seasons.

Variable Rate Seed

In addition to varying herbicides, crop seed rates can also be varied. Increased seed rates in the weed patch are used to increase crop competition and reduce weed vigour. This is generally simpler to apply than variable rate herbicide, too.

Variable Rate Herbicide to Soil Type

Several soil applied residual herbicides make label statements indicating different label rates for different soil types, with different soil types often defined by soil texture and organic matter levels. This information could form the basis for variable rate applications of herbicide based on soil type, with data layers such as EM38 potentially being suitable for defining soil types. The advent of on-the-go pH sensors might also provide useful information for producing soil maps of herbicidal activity. While some growers may manually change rates on-the-go according to their assessment of soil type change, there are few examples of this process being automated and used widely.

Application

Herbicide application can be targeted site specifically by varying the rate of a single tank mix with high and low doses targeted to different zones, or with multiple products being turned on and off independently. Varying rates of a single tank mix is the simplest application and can be achieved with current boom spray technology without modification. Varying the rate of a tank mix is achieved by changing the overall application volume, therefore the range of rates that can be achieved will be limited by nozzle selection, pressure and targeted spray quality. A greater range of rates can be achieved by decreasing ground speed where application volume increases, but this may be problematic in practice. Nozzle technology such as pulse width modulation (Aim Command) allows a much greater range of application volume independent of ground speed and spray quality.

To target different herbicide products to different zones is more difficult. With current boom spray technology with a single tank mixture this requires different herbicide

products to be applied in separate applications. To achieve independent control of different herbicide products in one pass requires the use of direct injection systems or carrying two separate tanks at the same time that contain different products and are applied through two separate boom lines.

Conclusion

High density weed patches should be targeted with high efficacy treatments over several seasons to drive weed numbers down. Significant herbicide savings can be made by reducing inputs into low density populations, these savings are greatest when using high cost herbicides. It is important to monitor weed populations where herbicide application has been reduced for density increase and be prepared to treat where significant increases occur. Improved weed mapping systems and an annual weed surveillance program will help to ensure population increases are monitored and managed.

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