



Newsletter of :

"GRDC Project UA00124 – Understanding and management of resistance to Group M, Group L and Group I herbicides.

INTRODUCTION

The winter cropping season in Australia is still a bit patchy, with areas of below average rainfall in the West Australian wheat belt, northern NSW and southern and western Queensland. On the other hand some areas are looking good at present. Dry condition pose different weed management issues to good seasons, often related to potential income. If it doesn't look like a good season, you are loath to spend any more money than necessary, or forgo income by using a practice such as manuring to give a heavy blow to weed seedbanks.

With this in mind remember that the herbicide resistance freight train keeps on rolling. According to the International Survey of Herbicide Resistant weeds that globally there are now 217 species with resistant populations to 21 of the 25 modes-of-action leaving not a lot of wiggle-room with herbicides in many situations.

This issue reports on a blow-out in glyphosate resistance in South Australia's south east and covers

research showing reasons for the weedy success of barnyard grass. Some of the mysteries of brome grass are also unravelled.

The threat of resistance is compounded by the loss of herbicides around the globe. Europe has withdrawn two thirds of their pesticides and more are under review. European weed scientists are now going-back-to-the-future, looking at as many non-herbicide tactics as possible, with manure crops, mulching, cultivation, flaming, growing competitive plants (weeds?) they can manage to stop other weeds (plants?) growing. High tech solutions adapted from the military are another avenue for improve weed control in high profit enterprises, although we have been doing this for years.

This sounds strangely familiar to Australian ears as it is integrated weed management by another name. The world-first "Integrated weed management in Australian Cropping systems" manual was first released in 2006, and the revised edition is

about to hit the ether. Australian weed scientists saw the problems, looked at the big picture and have been researching and extending better weed management using IWM for the last 30 years. Problems create opportunities. Now the rest of the world must get on-board.

Harvest weed management has kept WA farmers cropping in recent years. The northern region team investigated whether it could be a tactic for north of Dubbo, NSW. Depending on the crop and weed species targeted, there appear to be opportunities for harvest seed management.

Our team members this edition are Jenna Malone and Sarah Morran from the University of Adelaide who keep an eye on Chris Preston.

Gardens are not made by singing 'Oh, how beautiful,' and sitting in the shade.

Rudyard Kipling 1865-1936

Glyphosate Sustainability Working Group visits the NSW Liverpool Plains to hear how farmer Dave Ronald deals with the problem.



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SURVEY FINDS GLYPHOSATE RESISTANT RYEGRASS IS WIDESPREAD IN CROPPING PADDOCKS IN THE SOUTH EAST OF SOUTH AUSTRALIA



Survey populations for the South East of SA treated with 570 g a.i. per ha glyphosate.

Key points

- *Sixteen per cent of annual ryegrass populations in the south east of South Australia are resistant to glyphosate*
- *Integrated weed management focussing on stopping the seed set of resistant survivors needs to be adopted immediately*

Over the past 15 years the University of Adelaide team has been conducting random surveys of major weeds species present in cropped fields in late spring across South Australia and Victoria. Seed samples are collected from fields at random during harvest. The samples are tested for resistance to several herbicide modes-of-action to determine the patterns of resistance in the different areas.

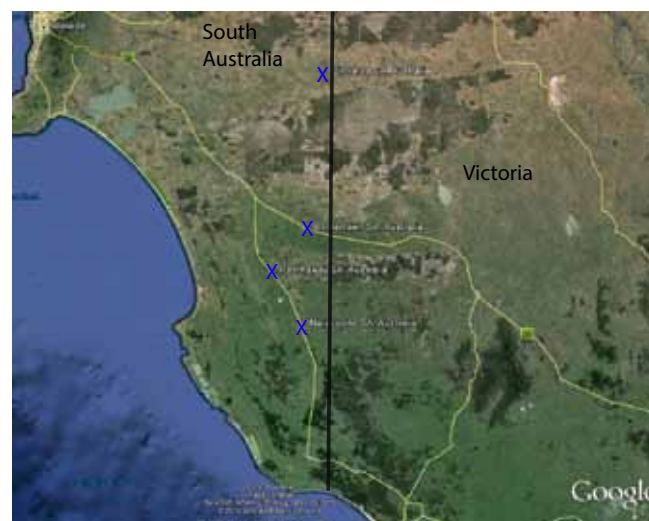
In the 2012 survey of the South Australian Mallee and the South East annual ryegrass was collected from 243 paddocks across the SA Mallee and 122 paddocks in the South-East. Seed was germinated in pots and were treated with 570 g per ha glyphosate at the two to three-leaf stage. Survival was recorded after 28 days and populations with more than 20 per cent of individuals surviving the herbicide application were recorded as resistant to glyphosate.

While none of the annual ryegrass samples collected from the South Australian Mallee survived the application of glyphosate 16 per cent of samples from the South East region were resistant to glyphosate. The majority of the resistant populations were from paddocks in the Naracoorte region; however isolated examples occurred near Coonawarra, Padthaway, Frances and Bordertown.

This work has identified glyphosate resistant annual ryegrass to be widespread in cropped paddocks in the South East region of South Australia and there is a need for growers to monitor their herbicide applications and to introduce integrated weed management tactics if they suspect glyphosate resistant weeds are present.

This research was supported by GRDC Grant UA00121.

Peter Boutsalis and Christopher Preston
School of Agriculture, Food & Wine, University of Adelaide



Area of survey. Google Earth image.

Key Points

- Awnless barnyard grass is a major weed of no-till farming in sub tropical Australia and tropical agriculture around the world.
- Twelve countries have herbicide resistant populations and two have multiple resistant populations.
- Barnyard grass was assumed to be self pollinating, however this research has shown out-crossing up to six per cent
- Barnyard grass populations can therefore maintain genetic diversity and individual plants accumulate genes for herbicide resistance.
- A range of herbicide and non-herbicide tactics are essential for the prevention and spread of multiple resistant barnyard grass populations.

Awnless barnyard grass (*Echinochloa colona*) is a major summer growing weed of crops and fallows in subtropical Australia. Populations of this species have evolved glyphosate resistance in fallow fields between Dubbo, NSW and central Queensland as a result of the intensive use of glyphosate in summer fallows. Currently there are 100 confirmed populations of glyphosate resistant barnyard grass in Australia. Currently many growers assume they have glyphosate resistance and manage accordingly without testing.

Globally herbicide resistant awnless barnyard grass has evolved in 12 countries to one or more modes-of-action including A, B, C, I and M. Multiple resistant populations to A, B and C occur in Costa Rica and Venezuela.

<http://www.weedscience.org/Summary/Species.aspx?WeedID=78>

Barnyard grass is considered to be self-pollinating. However gene flow via pollen between individual weeds in species such as annual ryegrass can transfer resistance which quickly spreads within a population. Cross pollination can also lead to rapid evolution of resistance to multiple modes-of-action within populations.

The work discussed here was undertaken to determine the likely level of the successful transfer of viable pollen between individual glyphosate resistant barnyard grass plants i.e. out-crossing.

How was it tested?

To determine the maximum potential for out-crossing in barnyard grass, resistant and susceptible pairs of plants were established in a pot with each pair being separated from the others. These plants were allowed to flower over summer under normal conditions with seed collected from the susceptible individuals when ripe. Some seed heads were bagged on each of the resistant and susceptible parents in each pair to generate self-pollinated seed as controls. The seed was germinated on agar and transplanted to trays. Seed was planted from the four susceptible treatments and from the 'selfed' susceptible and resistant controls.

Plants were treated with glyphosate at 240 g a.i. per ha when at the two to three tiller stage. This rate had been determined in dose response trials to be sufficient to control the susceptible population at this growth stage. At five weeks after application, the plants were assessed for survival (Table 1).

Table 1. Survival of barnyard grass plants treated with 240 g per ha glyphosate from self-pollinated controls and from the susceptible individual in four gene-flow pairs.

Seed sample	Plants treated	Plants surviving	% survival
S self-pollinated control	96	0	0
R self-pollinated control	80	80	100
S1	68	3	4.4
S2	554	24	4.3
S3	511	29	5.7
S4	891	20	2.2

This experiment demonstrated up to six per cent out-crossing in awnless barnyard grass. The implications for resistance management are:

- ➔ Barnyard grass will maintain genetic diversity within populations making it susceptible to the development of resistance.
- ➔ Barnyard grass will develop resistance to multiple modes-of-action as has already happened in Costa Rica and Venezuela.



Resistant and susceptible pairs of barnyard grass set up to test gene flow via pollen. Note the heads bagged to prevent pollen transfer between plants.

Therefore reliance on herbicides alone for the management of barnyard grass will lead to resistance to multiple modes-of-action used to control glyphosate resistant barnyard grass. Monitoring and control of herbicide survivors must be practiced. It is important to use a variety of non-herbicide tactics to manage barnyard grass.

Hoan Thai Nguyen, Jenna Malone, Peter Boutsalis and Christopher Preston
School of Agriculture, Food & Wine, University of Adelaide



GLYPHOSATE RESISTANT BARNYARD GRASS POPULATIONS EVOLVE SEPARATELY

Key points

- *Over one hundred scattered populations of awnless barnyard grass have been confirmed resistant to glyphosate*
- *Testing has shown up to six per cent out-crossing in this species which means it can transfer resistant genes between plants as pollen*
- *Implications are that barnyard grass populations are diverse and resistance has evolved as discrete events*
- *Seed spread is still important distribution mechanism*



While there is potential for barnyard grass to spread via seed movement by farm machinery, grain, livestock and flood waters, the rapid appearance of glyphosate resistant barnyard grass populations across the northern grain growing region suggests that resistance has been selected multiple times. However, the role of seed movement in spreading resistance in barnyard grass is not known.

In order to determine whether these scattered populations are spread by seed or evolved at separate sites, the genetic diversity of 62 barnyard grass populations from Queensland and New South Wales was determined. The populations were tested for resistance to glyphosate with 32 resistant and 30 susceptible. DNA was extracted from a single individual from each population and analysed for the amount of genetic diversity between populations. There were genetic differences between all the populations tested. An additional experiment examining 15 individuals from two resistant and one susceptible populations identified high levels of genetic diversity within populations as well. The amount of genetic diversity was as high in the resistant populations as in the susceptible population, providing no indication of a 'genetic bottleneck' occurring with selection for resistance to glyphosate. This means it will be easy to select for resistance to other herbicides in these populations.

This study has demonstrated there is a large amount of genetic diversity in barnyard grass in New South Wales and Queensland suggesting seed movement has not been a major contributor to the spread of glyphosate resistance. This genetic diversity has played a role in the widespread selection of glyphosate resistance in this species. With barnyard grass known to have populations of up to 1000 plants per square metre and high genetic diversity, the likelihood of resistant individuals existing before that herbicide is ever used is also high.



Hoan Thai Nguyen, Jenna Malone, Peter Boutsalis and Christopher Preston
School of Agriculture, Food & Wine, University of Adelaide

Key Points

- Two populations of great brome are now confirmed resistant to glyphosate.
- Glyphosate resistance in great brome is controlled by a single dominant gene making it easy to select.
- Control of glyphosate spray survivors with tactics such as double-knockdown is critical to limit the development of glyphosate resistance.

Great brome (*Bromus diandrus*) is a significant weed of both crops and pastures across the southern and western Australian cereal belt. It is an aggressive competitor of cereals and can cause large yield losses, and is also a host to a range of cereal crop diseases. In cropping situations great brome contaminates grain and reduces yield, while in pastures the seeds contaminate wool, damage hides and meat and can also cause injury to livestock by entering the eyes, mouth, feet and intestines.

In 2011, the world's first population of great brome was confirmed resistant to glyphosate. The resistant population was found in South Australia, surviving in a paddock where an old fence, previously managed for many years with glyphosate, had been removed, cropped over and a pre-sowing application of glyphosate applied.

The team at the University of Adelaide have been investigating the inheritance of glyphosate resistance in great brome with the hope of aiding the development of management strategies to reduce the selection for glyphosate resistance.

As great brome is self pollinating, hand crosses between a susceptible and a resistant plant were performed and two crosses successfully made. The two successfully crossed F1 (first generation) seeds were germinated and left to grow until flowering and seed set, when all seed produced from each plant was collected. This F2 (second generation) seed was then used to investigate inheritance. The F2 seed was germinated and 72 individual plants from each cross grown to tillering. At tillering each individual plant was split into 5, trimmed and re-planted, so that each individual plant

the number of resistant versus susceptible individuals of the 72 F2 plants of each cross was assessed. The two F2 families were found to segregate in a 3:1 resistant to susceptible ratio, consistent with a single dominant gene controlling resistance.

Further work will be undertaken to confirm a single gene is responsible for resistance in this weed species. These results show that glyphosate resistance in great brome is relatively easy to select. Intensive use of glyphosate without the control of survivors is likely to select for resistance in other populations. Recently a Victorian population of great brome was confirmed glyphosate resistance. It is important for growers to use a diversity of practices for management of great brome to lessen the risk of glyphosate resistance.



could be tested with different rates of glyphosate. Twelve plants from the both susceptible (S) and resistant (R) parents of the cross were also included. Once the cloned plants had re-grown and were at the two to three leaf-stage they were treated with glyphosate at 67.5, 135, 270, 540 and 1080 g a.i. per ha. A variety of responses were observed in the dose response, with both resistant and susceptible parental responses seen in the F2s. At the 135 g a.i. per ha rate, which was sufficient to control all of the susceptible plants while the resistant plants remained unaffected,

Response of susceptible (left front row) and resistant (right front row) and F2 (3 back rows) plants of brome to 270 g a.i. per ha glyphosate.

Jenna Malone, Peter Boutsalis, Sarah Morran and Christopher Preston

School of Agriculture, Food & Wine, University of Adelaide

Key Points

- *The proportion of seed collected depends on the time between weed maturity and crop harvest. The longer the time the more seed falls to the ground*
- *Seventy different weed species found in the survey*
- *Chickpea crops contain more weeds than wheat and the low harvest height increases the chance of collecting weed seeds*
- *Species showing the greatest potential for using harvest seed management because of height and amount of seed retained were sowthistle and wild oats*

Harvest weed seed management has been found to be highly successful at keeping the lid on weed numbers in southern and western cropping areas of Australia.

At present, harvest weed seed management is not practiced to any extent in the summer or winter cropping systems north of Dubbo, New South Wales. As the potential for this tactic had not been established in this region, surveys were conducted in northern NSW, southern, south-western and central Queensland cropping areas to identify which weed species that retained seed.

The surveys

A random survey was conducted in 1400 transects (each 10m²) across 70 paddocks of wheat, chickpea and sorghum in the four main cropping zones of the northern grain region during 2011 and 2012 (Table 1).

Table 1. Extent of the survey, number of weed species and proportion seeding at end of season, averaged across the different cropping zones

Situation	Number of transects (number of paddocks)	Number of species	% of species seeding above harvest height¥
Chickpea#	400 (20)	35	74
Wheat#	400 (20)	33	67
Sorghum*	600 (30)	38	82

survey conducted across Central Highlands, Darling Downs, South-west Downs and Liverpool Plains

* survey conducted across Central Highlands, Darling Downs and South-west Downs

¥ Harvest heights – chickpea = 5 cm; wheat = 15 cm; sorghum = 30 cm;

Data recorded in each transect were:

- ➔ weed species
- ➔ species density
- ➔ percentage of each species with mature seed

In addition, three representative mature plants of each species were collected from each crop paddock. These samples were used to determine total seed production and the proportion of total seed production retained above harvest height.

Findings

The majority of paddocks had a wide range of mature weed species with 70 different species identified in chickpeas (35), wheat (33) and sorghum (38) (Table 1).

No chickpea paddocks were weed-free, while one-in-seven sorghum and one-in-five wheat paddocks were weed free.

In winter crops, the most common weeds were sowthistle, fleabane, wild oat, brassica weeds and barnyard grass (Table 2). Infestations of these weeds were more frequent in chickpea than wheat crops, except for fleabane. As would be expected due to the low harvest height, chickpea crops had higher levels of weed infestation and greater proportions of weed seed production above harvest cutting height than wheat.

In grain sorghum and summer fallows, the most common weeds were sowthistle, fleabane, barnyard grass, feathertop Rhodes grass and bladder ketmia (Table 2). A greater proportion of mature sowthistle, fleabane and bladder ketmia plants were in sorghum than in fallow. Mature feathertop Rhodes grass, barnyard grass and pigweed plants were more common in fallow paddocks.

Table 2. The percentage of plants setting seed above harvest height (as for table 1) in the ten main weeds found.

Weed	Percentage of plants seeding above harvest height¥		
	Chickpea	Wheat	Sorghum
Common sowthistle	100	94	80
Flaxleaf fleabane	97	80	57
Feathertop Rhodes grass	-		68
Barnyard grass	58	100	23
Bladder ketmia	-	23	67
Wild gooseberry	-		6
Pigweed	-		0
Wild oat	100	100	-
African turnip weed	100	0	-
Turnip weed	97	0	-

¥ Harvest heights – chickpea = 5 cm; wheat = 15 cm; sorghum = 30 cm;

TEAM MEMBER PROFILE

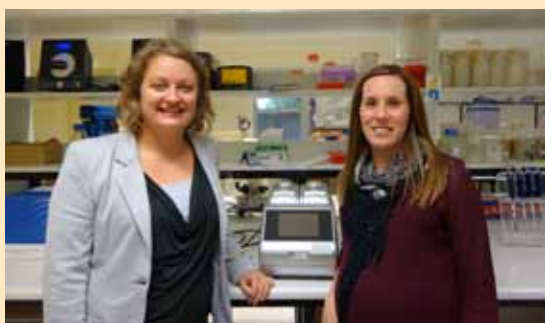
GET TO KNOW THE TEAM... Jenna Malone



Jenna completed a Bachelor of Biotechnology at Flinders University and her PhD through the University of Adelaide. Her thesis topic was the resistance interaction between barley and the fungus *Rhynchosporium secalis*. Jenna accepted a postdoctoral CRC for Australian Weed Management position with the Weed Management group at the University of Adelaide looking at the management of herbicide resistance in weeds of Australian cropping systems particularly glyphosate resistance. More recently she has worked on a RIRDC funded project on managing glyphosate resistance in non-agricultural areas. Jenna is currently on maternity leave following the birth of son, Ethan.

Sarah Morran

Sarah is a research assistant in the weeds research group at the University of Adelaide based at the Waite Campus near Adelaide. She is currently covering Dr Jenna Malone’s position in the group while Jenna is on maternity leave. Sarah has a background in drought research in cereal crops and has previously worked within the group on various projects including paraquat resistance in the pasture seed industry, impact assessment for genetically-modified canola in cropping systems and researching resistance mechanisms in various weed species. In her spare time she is finishing her up her PhD thesis which she hopes to have completed before she retires.



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IS HARVEST WEED SEED MANAGEMENT ‘ A GOER’ NORTH OF DUBBO?

Seed production on survivors

Seed retention at crop maturity for particular species was measured by visual assessment. Seed retention within a species varied according to cropping situation.

Table 3. Percentage of weed seeds retained at time of assessment for four weed species across three crops

	Wheat		Chickpea		Sorghum	
	% retained	Total seeds per plant	% retained	Total seeds per plant	% re-tained	Total seeds per plant
sowthistle	17	> 12 000	44	> 33 000		
African turnip			100	112 000		
wild oats	60	500				
feathertop Rhodes grass					58	> 50 000

Potential for harvest weed seed management

This study has identified some potential opportunity to collect and remove seed of several weed species during the harvest of both winter (wheat and chickpea) and summer (grain sorghum) grown crops in the northern cropping region. In this study high proportions of total seed production of wild oats and sowthistle were retained at crop maturity at a height that allowed collection during crop harvest. The proportion of seed collected will be dependent upon the time between weed maturity and crop harvest, with seed fall increasing with time.

Problems of grain staining may occur with indeterminate species such as sowthistle so this might reduce the value of weed seed harvesting and require salvage spraying instead.

Sorghum growers also need to be surveyed on how practical it is to take a greater proportion of crop bulk at harvest.

Steve Walker, QAAFI/ University of Queensland. RIRDC Project PRJ006834



WEED SYMPOSIUM PONDERES THE LOSS OF TWO THIRDS OF EUROPE'S PESTICIDES AND SHOWS AUSTRALIA IS LEADING THE WEED MANAGEMENT PACK

Key points

- *Europe has lost two thirds of its pesticides*
- *Pesticide laws will continue to become more proscriptive*
- *Much of the research is going back-to-the-future and looking at non-herbicide tactics to manage the changing weed flora*
- *The days of easy weed control appear to be over*

Overview

More than 300 delegates, predominantly from European countries, attended this four day symposium at the Ondokuz Mayıs University, Samsun, Turkey. There were 2 keynote and 35 oral presentations and 256 posters.

The program was an interesting mix of topics, without the normal predominance of papers on chemical weed control and herbicide resistance seen in Australian and North American conferences.



Keynote presentation

Per Kudsk, head of Research at Aarhus University, Denmark, gave one of the keynote presentations with an enlightening perspective on the challenges and opportunities for improving weed control in Europe.

The four main challenges are:

- ➔ Increasing complexity of pesticide legislation
- ➔ lack of new herbicide modes-of-action
- ➔ increasing number and spread of herbicide-resistant weeds
- ➔ emerging weed species

Currently, all registered pesticides in the European Union (≈1000) are being reviewed, which has resulted in 67 per cent of these products being removed from immediate use, 26 per cent approved, with the remainder still under investigation. The pesticide legislation introduced in 2011 has 'raised the bar' with new and stricter criteria for new registration submissions, that will further reduce the number of products coming to the

market. In 2014 it will be mandatory that all professional users of pesticides should adopt the principles of integrated pest management (IPM), although this has not been clearly defined.



Steve and Michael admire the flora on a Black Sea tourist beach - Noogoora burr and fleabane

Per Kudsk outlined six opportunities for improving weed control in the future:

- ➔ Better crop competition
- ➔ Use of strip tillage (such as robotic physical weeding between rows in high value crops)
- ➔ Optimising herbicide use site-specific weed management (using technology to identify and map problem weeds)
- ➔ Increasing biodiversity (weeds represent nature in arable fields)
- ➔ Biological control (few successes in cropping)

His conclusion was that the era of cheap weed solutions has finished, a range of alternatives need to be used in combination i.e. integrated weed management.

Non-chemical weed management

Caroline Halde from University of Manitoba, Canada talked on 'Prospects for reduced tillage without herbicides – a Canadian perspective'. Her project investigated options for organic reduced-tillage grain production. A green manure crop is grown in the first year in order to get 100 per cent weed seed control and reduce weeds in the following two grain crops, but the big issue is termination of the manure crop. A roller-crimper, minimum till rotary-hoe (Sounds like a contradiction in terms. Ed.), blade ploughs and grazing are being investigated. These systems still need fine-tuning to devise suitable green manure crops with sufficient biomass to suppress weed and optimum methods for termination of the manure crops. Also there is concern that the weed flora could change from annuals to perennials and whether this system is profitable. (Manuring has been shown to be effective and economic in a number of Australian systems. Ed.)

Elad Hayut from Israel discussed the use of cover crops to suppress weeds in citrus orchards. Benefits from cover crops included increasing soil carbon and improving pest management by providing pollen for predator mites. The most successful cover crop was the autumn-sown oat and vetch mixture, which provided over 80 per cent weed suppression.

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WEED SYMPOSIUM PONDERES THE LOSS OF TWO THIRDS OF EUROPE'S PESTICIDES AND SHOWS AUSTRALIA IS LEADING THE WEED MANAGEMENT PACK

although efficacy differed between weed species. The summer-sown cover crops were not successful due to the dry conditions and present a problem of using limited water resources.

Carolina Puig from Spain showed the benefits of incorporating the herb apple mint (*Mentha suaveolens* - <http://www.kew.org/plants-fungi/Mentha-suaveolens.htm>) for weed control in maize cropping. Pots studies showed that incorporation of the green manure crop of apple mint, which is a perennial, provided 90 per cent control of annual grasses, including barnyard grass, and provided 99 per cent control of number of broadleaf weeds, but did reduce emergence of maize seedlings (Oooops. Ed). The solution was a two week delay in sowing the maize. This approach needs to be tested in the field, particularly how to produce the quantity of apple mint needed for successful weed control. If successful apple mint manure crops may be an alternative to pre-emergent residual herbicides, such as metolachlor (Dual® Gold).

Lynn Tatnell from UK is investigating the feasibility of the electrocution of tall perennial weeds in horticultural crops using shielded high-powered electrodes in the same manner as wick wiping with herbicides. Level of control depended on weed species and contact time, but not voltage. (It's the amps that kill. Ed.) A prototype with shielded units for use in annual vegetable crops has been constructed and initial results showed promise on several broad-leaved weeds.

The final non-chemical presentation was by S Knezevic from Serbia, who compared research on effects of flaming and cultivation on weed control in maize in Serbia and USA. Field experiments at different sites evaluated different cultivation (inter-row cultivation, flex-tine harrow) and flaming (broadcast, band, doses) combinations at different growth stages of maize. The flaming treatments utilised propane. The integration of tine harrow with two applications of flaming provided acceptable and sustained weed control with minimal crop damage. (See work by Johann Ascard, Sweden, from the 1980's and 90's. Ed.)

Other sessions

Many of the weed biology and ecology presentations and posters were specific to European problems, although there was much to learn from the principles developed. Interestingly, there was a strong interest in maintaining biodiversity, in which European arable weeds have an integral role.

In the herbicide resistance session, the invited presentation was by Michael Renton from University of WA (with co-author David Thornby) from Australia on the importance of modelling to help understand the ecology, management and genetics affecting the evolution of herbicide-resistant weeds. In the poster session, there were three on glyphosate-resistant fleabane, three on resistant barnyard grass species, and numerous on mechanisms for target site and non-target site resistance in several species, including fleabane.

Jasper Rasmussen from Denmark created a lot of interest with the role of unmanned aircraft systems in weed management. With recent improvements and availability of this technology, that is relatively inexpensive, user-friendly and reliable, unmanned aircrafts have potential for mapping patchy weed infestations and quantifying crop damage. Currently they are concentrating on automated image analysis procedures to identify and map weeds. (Believe the US may impose restrictions on civilian use of drones because of fear of terrorist activity. Ed)

Steve Walker, QAAFI

Entrance to the university hosting the European Weed conference



The father of modern Turkey – Mustufa Kemal Atatürk was even in the presentations.



IT ISN'T JUST JACK LIVING HERE, GLYPHOSATE RESISTANT AMARANTH NOW IN ARIZONA

Arizona has its first documented case of herbicide resistance to a weed - Palmer amaranth (*Amaranthus palmeri*) from a cotton crop in Buckeye.

Bill McCloskey, University of Arizona Extension weed specialist, confirmed the first case of resistance of Palmer amaranth to glyphosate from the 2012 season.

"It was only a matter of when," McCloskey said. "Glyphosate is the predominant weed-management strategy used by Arizona cotton growers year after year."

Bill was surprised the first Arizona case of resistance was found in cotton. He expected resistance first in tree crops since glyphosate can be applied up to eight times annually for weed control.

The resistance alarm first sounded last summer when a Buckeye cotton grower and several agronomists contacted Bill. The concern was a 32 ha cotton field with a severe amaranth infestation after several applications of glyphosate.

Glasshouse tests from December confirmed glyphosate resistance in the first field. In fact, the resistance levels were among the worst found in the U.S.

"It seems to be endemic in the Buckeye area in a wheat-cotton double crop scenario without tillage and pre-emergence herbicides," McCloskey said. "Roundup was the only herbicide applied during the warm times of the cotton season."

McCloskey received a call several weeks later from an agronomist in Glendale with a problem related to pigweed control with glyphosate although glasshouse results were negative for glyphosate resistance.

Buckeye and Glendale are located just west of Phoenix.



For the 2013 Arizona cotton season Bill suggested the following management:

- ➔ Start with a clean field. Use tillage preplant, in-crop cultivation, and post harvest
- ➔ Hand rogue before seed set
- ➔ Use multiple herbicides with different modes-of-action such as trifluralin (Group D)
- ➔ Scout the fields after each herbicide application
- ➔ Crop rotation provides improved herbicide effectiveness through the use of multiple technologies such as lucerne.

To implement the production practices mentioned above, Bill said these efforts could increase production costs from \$50 to \$100 per hectare.

How likely could herbicide resistance spread to other Arizona cotton-growing regions? Bill said, "Much of it will depend on whether the grower community continues to grow cotton as they have in the past or whether they change their production practices. This is a manageable problem with good management and the use of a wide diversity of tools."

Resistance can be spread by amaranth pollen and seed. Seed numbers per plant can range from 600 000 seeds to 1.6 million seeds per large plant. An infestation of 5 plants per metre of the crop row can produce 1.5 billion seeds per hectare.

Adapted from Western Farm Press <http://westernfarmpress.com>



With the USA having huge areas of crop compared to Australia, it is interesting to know which are the major herbicides used. The following information is from a USDA National Agricultural Statistics Service (NASS) survey conducted in 2012.

Soybeans

Herbicides were applied to 98 per cent of the 31 million hectares US soybean crop in 2012, which was the same proportion seen in the 2005 survey.

Glyphosate herbicide was applied to nearly 90 per cent of the US soybean area with 32 million kilograms of the potassium salt of glyphosate were applied to 60 per cent of the area and 14 million kilograms of the isopropylamine salt were applied to 30 per cent of the crop. The NASS conducted the survey in 19 states, which accounted for 96 per cent of the US soybean area. The Service's last survey of pesticide use on soybeans in 2005 found that some 30.5 million kilograms of glyphosate was applied to 93 per cent of the crop.

The next most popular herbicides used on soybeans were chlorimuron-ethyl (Classic® - Group B), 2,4-D and flumioxazin (Pledge® - Group G), which were each applied to 11 per cent of the area. Applications of 2,4-D amounted to 1.9 million kilograms, flumioxazin to 274 000 kgs and chlorimuron-ethyl to 85 000 kgs. In 2005, 2,4-D was applied to 6 per cent of the surveyed crop, followed by trifluralin and chlorimuron-ethyl.

Wheat

There were 23 million hectares planted to wheat in 2012, which made up of 17 M ha of winter wheat and 6 M ha spring wheat.

Herbicides were applied to nearly all of the spring wheat crops. Some 99 per cent of durum wheat (~ 1 M ha) received a herbicide application and 97 per cent of spring wheat was treated. The survey found that 60 per cent of winter wheat was sprayed with herbicides.

The most widely used herbicides on durum wheat were bromoxynil, glyphosate and fluroxypyr. On other spring wheat, the herbicides most used were fluroxypyr, clopyralid and bromoxynil. The leading herbicides used on winter wheat were thifensulfuron, 2,4-D and metsulfuron-methyl.

<http://www.grdc.com.au/Resources/App-Store>

Ken Young, GRDC, showing farmer Dave Ronald and agronomist Pete McKenzie the finer points of the GRDC Weed ID app.



GRDC
Grains
Research &
Development
Corporation



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Department of
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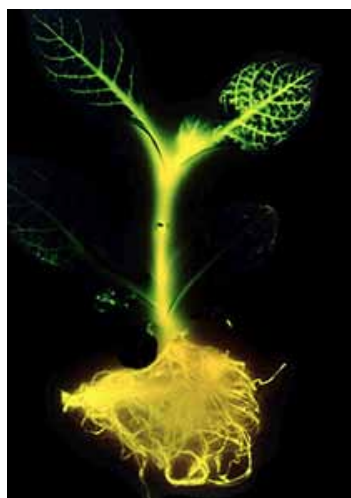
QAAFI
Queensland Alliance for
Agriculture and Food Innovation



JSA independent



AGRONOMO



Things of interest

Gene manipulation to save power -
Forget those garden lights, grow a tree!

<http://www.smithsonianmag.com/ideas-innovations/Creating-a-New-Kind-of-Night-Light-Glow-in-the-Dark-Trees-215077381.html>

<http://www.kickstarter.com/projects/antonyevans/glowing-plants-natural-lighting-with-no-electricity>

Glyphosate resistance good for jobs!!!!

<http://deltafarmpress.com/cotton/photos-high-school-cotton-choppers-hit-delta-rows>

Chipping crops making a comeback in the US, but at a cost.

<http://deltafarmpress.com/soybeans/pigweeds-chopping-costs-burning-fields-and-moldboard-plows>

Chopping costs gone from \$8 to \$50 per hectare because of GR amaranth.

Some growers now using paraquat around edges of fields and in ditches plus mouldboard ploughs in the paddock.



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