giving a RATS

HEADS-UP FOR NEW GLYPHOSATE RESISTANCE!!

Glyphosate resistant sowthistle in fallow. A. Storrie

The thing about working with Nature is that it never fails to surprise or excite. Yes, believe it or not weeds are part of Nature and they keep showing how adaptable they are.

The Northern farming system has again demonstrated how good it is at producing glyphosate resistant weeds with the 'almost officially confirmed' world first of glyphosate resistant sowthistle (*Sonchus* spp).

Two populations from northern NSW are in the final stages of testing, but anyone with experience 'in the business' will consider it a 'dead cert'. Interestingly enough one population was collected by the Australian Glyphosate Sustainability Committee during its last field tour in June.

"We knows one when we sees one" has become the Group's motto.

For more information contact Tony Cook, NSW DPI, Tamworth.

Western Australia's first case of paraquat-resistant annual ryegrass has just been identified in a vineyard near Albany, the home of this newsletter. The wineries here produce Riesling, shiraz, and now paraquat and glyphosate resistance.

Another TWO populations of Brome grass (*Bromus* spp.) – from both South Australia and Victoria – have been confirmed resistant to glyphosate. These have appeared to have been selected within the field and not along fence lines.

These are a particular concern because brome grass is much harder to manage than annual ryegrass. For further information contact Chris Preston, University of Adelaide.

Resistant (left) and susceptible sowthistle after 1.5 L/ha Touchdown® T. Cook

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Quote:

The true delight is in the finding out rather than in the knowing.

Isaac Asimov 1920-1992

Paraquat resistant annual ryegrass in a Western Australian vineyard. A.Storrie

Dry conditions in the northern wheatbelt of Western Australia and parts of eastern Australia are tempting growers to stop doing any harvest weed management. "There doesn't seem to be many seeds on those annual ryegrass plants", I can hear you say. That's where you are wrong.

Research by the Australian Herbicide Resistance Initiative (AHRI) has shown that annual ryegrass can produce high seed numbers in poor seasons (Table 1). These can carry over to the following year and reduce yields. Note the comparative ryegrass seed yields for the two seasons. Not much of a yield penalty for ryegrass in a drought year when compared with wheat.

Table 1: Wheat yield and annual ryegrass seeds produced over 2 years.

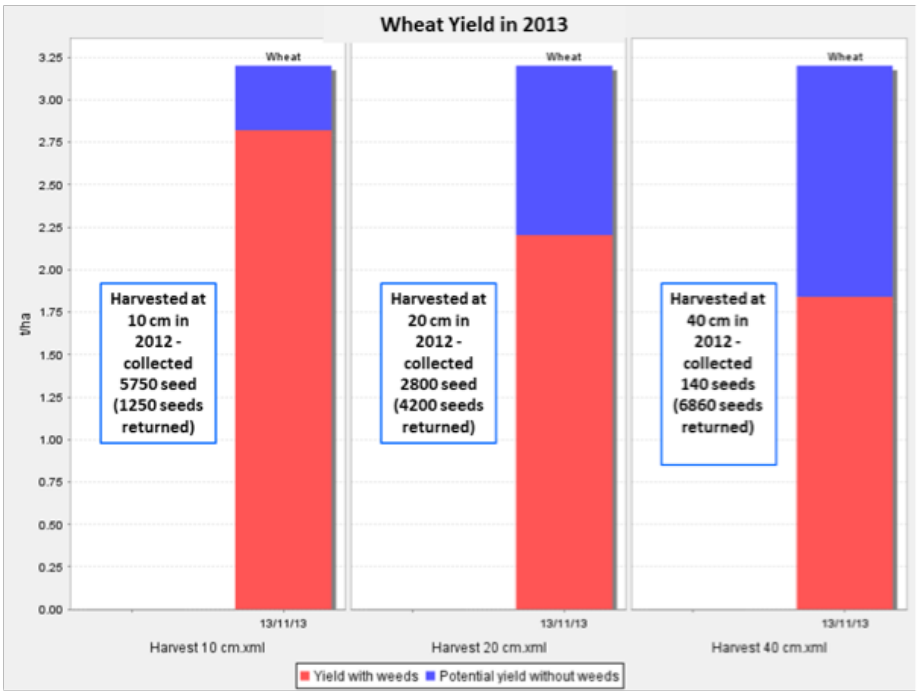
Year	Wheat yield	Annual ryegrass	
	(t/ha)	(plants/ m^2)	(seed/ m^2)
2011	4.0	19	12,000
2012 (dry)	0.6	29	7,000

Cut your crop lower in a dry year to catch more ryegrass seeds. In a good year with a big crop, there will be less light penetration and the annual ryegrass tillers will be upright and easier to catch. In a low-yielding year with a light crop and an open canopy, the ryegrass tillers will be also shorter. The research by AHRI showed that at 40 cm harvest height in 2011 (high yielding crop) collected about 60 per cent ryegrass seed at crop maturity compared to about 2 per cent in 2012 (low yielding crop).

The more seeds dropped in one year, the less yield in the following year. To illustrate the difference in cutting height in a dry year, The Weed Seed Wizard was used to simulated wheat yields in 2013 after 7,000 annual ryegrass seeds/ m2 were set in 2012. If the crop was cut at 10 cm, only 1250 ryegrass seeds/m^2 are returned to the seedbank with a wheat yield loss of 400 kg/ha the next season. This compares to a yield loss of 1.4 t/ha when the crop is cut at 40 cm and most of the ryegrass seeds are dropped.

In dry years where wheat yield is low, it is still possible to burn narrow windrows in wheat. For wheat crops of 2.5 t/ha or less it is possible to burn just the windrows. Cutting low is imperative to keep the fire in the windrow and to optimise burn temperature.

Keep up harvest seed management in dry seasons. A.Storrie



Sally Peltzer, DAFWA, Albany and Alex Douglas, DAFWA, Katanning

- Palmer amaranth (pigweed) (*Amaranthus powellii)* is a huge problem in southern US farming systems. (See Giving a RATS – Edition 5 page 10)
- Palmer amaranth's weak spot is its short-lived seedbank.
- Waterhemp (*Amaranthus tuberculatus*) is the major glyphosate resistant weed in the mid-west.
- Big push is to use pre-emergent herbicides with Roundup Ready® crops.

In late August I have had the good fortune to be invited to participate in a Bayer Crop Science tour of glyphosate resistance hotspots in the south and mid west of the United States of America. This tour started with a bus trip from Lubbock to Amarillo, Texas. This area is dominated by huge centre pivot irrigators of cotton, corn and, to a lesser extent, soybean. Interestingly, this area is the centre of origin of the major weed Palmer pigweed. Palmer pigweed is everywhere and indeed the dominant plant in the agro-ecosystem. It is a MASSIVE weed, capable of growing taller than the 2.5 metre high fabulous irrigated corn crops! Glyphosate resistant Palmer pigweed is becoming a major problem in these irrigated crops and the farmers and consultants are only now starting to grapple with how they are going to manage this major challenge to their intensive irrigated cropping.

From Texas the tour moved to Arkansas, touring areas (near Memphis, Tennessee) with major glyphosate resistant Palmer Amaranth infestations. From the bus we viewed many cotton and soybean crops with amaranth infestations. However, we also visited a grower who has got on top of the problem and now has reduced amaranth seedbank to very low levels by alternating Roundup Ready® and Liberty Link® (glufosinate resistant) crops. Several proactive farmers who told me that battling Palmer amaranth is a very serious issue and while it can be done it requires considerable effort. The biological weakness of Palmer amaranth is that it has a very short seedbank life. Thus, harvest weed seed collection (HWSC) practices are likely to work. Thus far the HWSC practice has been the very expensive hand-hoeing teams to remove large Palmer amaranth plants late in the season and this practice has worked in reducing seedbanks. There is a big opportunity for our various Australian HWSC techniques to be used.

The tour then moved to Illinois and the equally fabulous corn-soybean cropping fields of the mid-west. The US has such fantastic agricultural land. Magnificent crops, fabulous soils and great infrastructure! The glyphosate resistance problem is currently much less in the mid-west than the south but there is plenty of evidence of glyphosate resistant waterhemp in Illinois. The bus headed south from Chicago, passing through fabulous cropping country and I talked with several successful farmers, crop consultants and others. Roundup Ready® crops totally dominate the landscape which means the majority of farmers continue to rely on glyphosate thus making resistance is inevitable. Most are unlikely to change until they have a disaster!

I spent a little time at the huge Farm Progress Show at Decatur, Illinois. A massive event displaying cropping machinery, agricultural companies and everything else you can think of. Many thousands of farmers visit to view the equipment. (All farmers are the same then. Ed.) All the chemical companies had impressive displays.

I had a full day tour of central Illinois with Aaron Hager and Pat Tranel of the University of Illinois. We drove on small roads viewing great soybean and corn crops. Waterhemp sprinkled through many soybean crops with a small number having high infestations and many with little or no infestation. Only a few corn fields had waterhemp out above the tall corn crop. Thus, glyphosate resistance is taking off and in my view poised to explode but not yet as dire as in the South. Farmers are going to continue to use the current Roundup Ready® system but also utilise pre-emergent herbicides. While this is giving reasonable control it will not be enough to prevent a glyphosate resistance blowout.

Steve Powles impressed by how well Palmer amaranth grows.

In conclusion, there are many glyphosate resistant weed problems underway in the US south and mid west and there will need to be major adoption of more diverse and integrated systems than currently practiced. In my view these changes will be forced by widespread development of glyphosate resistant weeds. The changes will be difficult as US farmers are totally herbicide dependent and very reluctant to change from the continuous Roundup Ready® crops that have served them well this past 15 years. However, they will have to learn as we have in Australia that the only sustainable way forward for crop weed control is diversity, use of non-chemical tools and broader rotations.

Steve Powles, Australian Herbicide Resistance Initiative

GLYPHOSATE RESISTANT ANNUAL RYEGRASS NUMBERS INCREASE IN SOUTH EAST WA

- ➔ In 2013 another 14 glyphosate resistant annual ryegrass populations were confirmed in the south east coast of WA
- ➔ The total for this region is currently 69
- ➔ There will 150 seed tests in the central agricultural zone of WA this harvest

As part of the GRDC-funded herbicide resistance project, The Esperance Advisor Group tested for glyphosate resistance in April/ May 2013. They employed Jan Clawson from South Eastern Premium Wheat Growers Association (SEPWA) to collect 54 annual ryegrass plant samples from a 150 km radius around Esperance in the south east of Western Australia.

These were sent to Peter Boutsalis (Plant Science Consulting) for a Quick-test™ at two rates of glyphosate (1.5 L/ha and 3 L/ha of 540 g a.i.). The Quick-test™ is a simple method where plants (mainly grasses) growing in the paddock can be tested for resistance to post emergent herbicides.The ryegrass plants were trimmed and planted into pots to allow new leaves to grow for a week before being sprayed with the two rates of glyphosate.

Fourteen samples (26%) were resistant (or developing resistance) to 1.5 L/ha glyphosate and 11 were also resistant to 3 L/ha glyphosate.

The historical results were added to this making a total of 69 confirmed cases of annual ryegrass resistant to glyphosate in the eastern south coast of W.A.

+ 18 other resistant samples from the eastern south coast sent to Peter Boutsalis for testing (2011 to 2013)

+ 18 resistant samples (47% from a random survey in 2010 (AHRI) (17 developing resistance, 1 fully resistant and 20 susceptible)

+ 19 resistant samples earlier on the Glyphosate Resistance register (AGSWG)

Many growers paid to test the same populations for resistance other modes-of-action. The popular resistance test was for clethodim (Select®) and it was found that 38% were resistant to 350 mL/ha and 20% to 500 mL/ha.

This harvest there will be some seed testing across central Western Australia. The annual ryegrass seeds will be tested for the same two rates of glyphosate under this funding arrangement but the growers will also have the opportunity to test and pay for other herbicide tests. If you or your central WA clients suspect glyphosate resistance and would like to be part of this project, please call Sally Peltzer on 0407423047 or email

sally.peltzer@agric.wa.gov.au

Sally Peltzer and the Esperance Advisor Group

SHeRA – management modelling approach

Key Points

- ➔ Resistance management is now the focus of farmer strategies
- ➔ Patch management has the potential to cut weed control costs and reduce herbicide usage
- ➔ SHeRA computer model indicates that differential management of the weed patch and the surrounding area can be highly effective in stopping spread of resistant weeds

In Australian agriculture, the emphasis on dealing with resistance (to glyphosate in particular) is shifting from prevention to management. Current strategies for managing resistant weeds include important tactics for particular weed species and systems, like harvest weed seed management in the west, or double-knocking glyphosate-resistant fleabane in Queensland and NSW. To date, however, they don't include attempts to restrict the movement and expansion of patches of resistance early on, or even to eradicate patches when it might be possible to do so.

Over the last two decades we have developed a good understanding of how, why, and when resistance occurs. However questions remain about the spread of resistance:

- ➔ how patches grow, move, and spawn new patches
- ➔ at what rate this occurs for different species

Understanding the behaviour of resistance across a paddock could help us decide whether, and under what conditions, local eradication of resistant populations is feasible. It will also be useful to identify cost-effective patch management that could be used to achieve it.

In order to examine the spread of herbicide resistance, the computer model SHeRA - the Spatial Herbicide Resistance Analyser - was developed to analyse weed life cycles and gene flow. Sub-populations of weeds of 1 m^2 each, arranged in a grid, are subjected to a set of management tactics and, during flowering and seed set, communicate with each other through short- and long-distance movement of pollen and seeds. SHeRA tracks the fates of individual weeds once they germinate, but treats pollen and seeds as groups.

Patch dynamics in an agricultural weed result from the tension between the patch population's pressure for expansion and to create new, separate patches, and the manager's pressure for containment and eradication. In the case of resistance, patch expansion occurs both through seed dispersal and through pollen flow from resistant patches to the surrounding susceptible population.

Early results

SHeRA was tested on simulations of glyphosate-resistant awnless barnyard grass in a glyphosate-resistant cotton enterprise. A simple test of patch dynamics is shown in Figs 1-3. Three scenarios were simulated:

- ➔ glyphosate used alone after the emergence of every cohort (Fig 1);
- ➔ the glyphosate strategy plus paraquat applied to every cell in a containment zone 14m^2 across, around the original resistance patch (Fig 2); and
- ➔ the glyphosate strategy plus paraquat applied only to cells in the original patch area (Fig 3).

As expected, glyphosate used alone allows the patch to spread. The addition of paraquat was very successful at limiting spread when applied in a zone outside the original patch, but failed when applied only in the original area of the resistant patch, where it allowed a few escapes to get into the glyphosate-only treated area, and then proliferate.

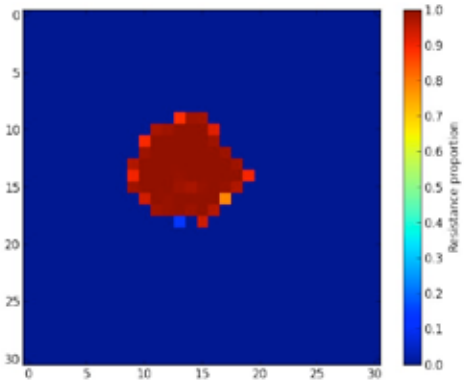


Fig 1. Resistance proportion in each cell of a test field after five years of glyphosate applied after emergence of every cohort

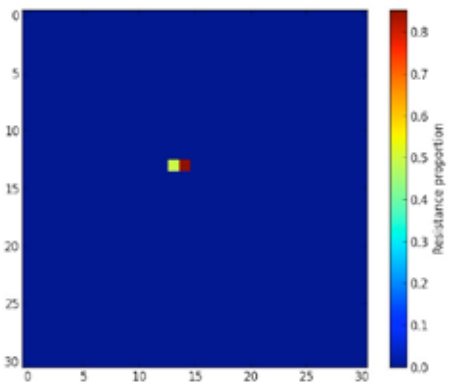


Fig 2. Resistance proportion in each cell of a test field after five years of glyphosate applied to every cohort plus paraquat applied to every cohort in a zone 14m^2 across, around the original resistance patch.

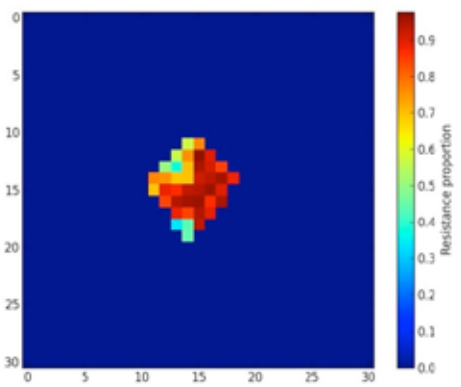


Fig 3. Resistance proportion in each cell of a test field after five years of glyphosate applied to every cohort plus paraquat applied to every cohort in the 4m^2 diameter of the original resistance patch

WHY NOT TREAT PATCHES AS PATCHES?

When a patch of herbicide-resistant plants is identified on farm, the affected grower could choose to either manage the whole area as if it were herbicide-resistant, or to isolate the patch and some surrounding area, and treat them differently from the rest of the paddock. Treating the paddock in different zones might be harder to organise, but is lower-cost if successful. In SHeRA, we nominate the original patch as the eradication zone, an area immediately outside the patch as the containment zone, and the rest of the field as the background zone. The eradication zone should receive highly intensive management aimed at preventing all seed set on all emerged plants, for as long as necessary to exhaust the supply of resistant seeds. The containment zone should receive management robust enough to ensure that recruits from short-distance gene flow are likely to be controlled. The background zone receives some version of 'business as usual' management, which in a best-management-practice case would consist of glyphosate plus a range of options able to prevent the successful establishment of satellite patches of resistance that occur due to pollen movement.

The next step

SHeRA will first be used to investigate the potential for eradicating glyphosate-resistant patches of awnless barnyard grass in cotton farming and to optimise management tactics used in each zone. Recommendations will be developed for on-farm use where glyphosate-resistant awnless barnyard grass patches are identified. The development and implementation of these strategies will be critical in determining the medium to long-term sustainability of glyphosate-tolerant cotton farming in Australia.

David Thornby, Senior Research Scientist (Weed Management) Agri-Science Queensland

TEAM MEMBER PROFILE

Steve Walker is Associate Professor with the Queensland Alliance for Agriculture and Food Innovation (QAAFI) at The University of Queensland. Formerly Leader of the Weed Science team for Queensland DEEDI and a Program Leader in the CRC for Australian Weed Management. Currently leads a weed research program on the issues relating to herbicide resistance, modelling, integrated weed management in grain and cotton farming systems, safe and effective use of herbicides, non-chemical tactics and weed ecology.

Andrew Storrie is Executive officer of the Australian Glyphosate Sustainability Working Group and private extension training and weed management consultant based in Albany, W.A. Andrew was Technical Specialist Weeds and Weeds Agronomist for 15 years based at Tamworth, with NSW Department of Primary Industries and spent half his time running various projects with the CRC for Australian Weed Management. Andrew is editor and major contributor to "Integrated Weed Management in Australian Cropping Systems – Editions 1 & 2". Prior to this he was District Agronomist at Griffith and Hillston in the NSW Riverina for 15 years.

Sally Peltzer assessing Stirlings-to-Coast (WA) fence line trial. A. Storrie

- Approximately one quarter of glyphosate resistant annual ryegrass across Australia has been found in fencelines and so their management is imperative.
- Spraying once to control weeds in fencelines or firebreaks does not give complete control no matter which time of the year you spray. This leads the way for these weeds to set seed.
- Spray twice, once early in the year (pre-emergence and before seeding) with a residual and a knockdown herbicide if needed, followed by a knockdown later in the season. Weeds in fencelines, firebreaks and fallows should be a priority for resistance management and not just another job.

Weeds in fencelines have no competition from the crop, are usually sprayed later in the season (August/September) when they are big and hard to kill, and are sometimes sprayed repeatedly with glyphosate. All growers are busy trying to stop herbicide resistance from developing within their crops. While weeds in paddocks are an economic focus of farms, weeds in fencelines and roadways can sometimes be overlooked and put off as a job for the slower times.

There are two GRDC-funded Advisor groups in WA (Northern Ag region and Esperance). In 2012, the two Advisor Groups explored alternatives to glyphosate in two fenceline trials to prevent the onset of resistance in annual ryegrass. Tank mixes of residual herbicides with either paraquat or Alliance® (paraquat + amitrole) gave the best control of annual ryegrass, wild radish and other grasses and broadleaf weeds at both Esperance and Dalwallinu. In 2012, the herbicide treatments were applied in August which tends to be a common time for many growers. In August however, the weeds are large and often harder to control.

In 2013, the Northern group looked at another batch of alternative herbicides for fencelines and fallows as well as some more common tank mixes (such as atrazine + 2,4-D + paraquat). These were applied at two earlier application times, May and early July, at trials located at Miling (Liebe Group Field Day site), Dandaragan (West Midlands Field Day site), South Stirlings (Stirlings to Coast Field day) and Geraldton. Similar results were recorded; a mixture of a residual and a knockdown gave the best control. The standout treatments for 2013 were:

- atrazine + Alliance®;
- Trimac® + Alliance®; and
- atrazine + 2,4-D ester + paraquat.

BUT, while some of the treatments gave 98% control, none of them offered complete control. After looking at the Miling site in early August, the Group decided that it should have an extra knockdown (glyphosate and paraquat was sprayed in strips across the treatments) in mid-August about 3 weeks before the field day. It worked very well with complete control, highlighting the need to keep the bulk down early for a good late tidy up.

The success of this tactic at Miling now leads the way for trials in 2014.

There will be two sprays in trials in 2014, once early in the year (pre-emergence and before seeding) with a good residual and a knockdown if needed, followed by a knockdown later in the season (after the seeding and post-harvest operations are over). This tactic allows you set up the fencelines early in the season then kill them off later rather than having to spray big fat weeds in in one pass.

Sally Peltzer, Department of Agriculture and Food WA, with the Esperance and Northern Advisor Groups

Dave Nicholson, DAFWA, proud of his efforts with the Geraldton fence line trial in 2013.

- Non-cropping weed management sector continues to be oblivious to herbicide resistance
- Strategies need developing to raise the profile of herbicide resistance within the non-crop weed management community

July saw the 2013 'Weeds are everyone's business' Queensland Weed Symposium, held at the whale-watching capital of Hervey Bay. While the symposium covered many topics regarding weed management in non-cropping situations few included an awareness of, or work on, herbicide resistance. It appears messages about herbicide resistance are not reaching the ear of that wider audience.

In recent years it has been amply demonstrated that herbicide resistance is a real threat for all land managers not just for broadacre farmers. Herbicide resistance is found increasingly in non-cropped areas, especially on utility areas like roadsides and railways, but if this year's QWS presentations are any indication, resistance is far from the minds of those making decisions about weed control in these areas.

The symposium attendees were treated to discussions about robotics, weed seed hygiene, strategies, plans, and mobile phone apps. There were presentations on a range of topics, broadly falling into the following categories:

- Communications; story-telling; building and using community participation in weed management.
- Weed spread; invasion biology; naturalisation of new species.
- New tools and technologies for weed surveillance and control.
- Specific biology and control of some key environmental weed species.

Communication, in particular, touched a nerve for many attendees. Econnect's Jenni Metcalfe discussed the importance of story-telling, while Department of Agriculture Forests & Fisheries' Kym Johnson unveiled future approaches for internet-based community participation in weed surveillance. Landcare Australia's Brett de Hayr spoke about Landcare's changing position in the context of mobilising people – as individuals and in groups – to keep working towards community-level goals in weed management.

Good communications are vital to introduce the possibility of behaviour change. While herbicide resistance is just one of a wide range of weed management issues that need discussion, thought, and action, the minimal attention paid to it by speakers at the symposium raises the issue of why this group of weed managers are not being reached by the resistance message. Clearly more needs to be done to crystallise in the minds of the non-cropping sector the challenges posed by herbicide resistance before it's too late.

David Thornby, Senior Research Scientist (Weed Management) Agri-Science Queensland

Craig Magnussen chairing – Queensland weed symposium 2013 missed the herbicide resistance threat.

NO MORE HIGH VOLATILITY 2,4-D ESTER

Cotton damaged by 2,4-D.

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has cancelled 11 high volatile ester (HVE) products, retailed as ester 800, as part of the agency's ongoing review of 2,4-D (2,4-dichlorophenoxyacetic acid).

The products have been widely used in broadacre agriculture and sugarcane. The decision means:

- supply of cancelled 2,4-D HVE active constituent has ceased (effective as of 21 August 2013)
- supply of cancelled product manufactured prior to 21 August 2013 has ceased from Saturday, 31 August 2013
- products already purchased can be used up until 31 August 2014, under the same permit instructions (PER14329) that currently apply - this permit restricts use to 'winter only' under strict conditions
- use of the existing products after 31 August 2014 will be illegal.

The decision follows the APVMA's July report Annex to the APVMA's Preliminary Review Findings (Environment) Part 1: 2,4-D Esters Volume 1: Review Summary and advice to selected 2,4-D HVE registrants and approval holders of the intention to cancel selected registrations and approvals on the basis of unacceptable environmental risks.

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