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Viewpoint

Australia's pesticide environmental risk assessment failure: The case of diuron and sugarcane

Glen Holmes *

School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD 4072, Australia

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ABSTRACT

In November 2012, the Australian Pesticide and Veterinary Medicines Authority (APVMA) concluded a 12 year review of the PSII herbicide diuron. One of the primary concerns raised during the review was the potential impact on aquatic ecosystems, particularly in the catchments draining to the Great Barrier Reef. The environmental risk assessment process used by the APVMA utilised a runoff risk model developed and validated under European farming conditions. However, the farming conditions in the sugarcane regions of the Great Barrier Reef catchments have environmental parameters beyond the currently validated bounds of the model. The use of the model to assess environmental risk in these regions is therefore highly inappropriate, demonstrating the pitfalls of a one size fits all approach.

1. Introduction

Diuron or DCMU (3-(3,4-dichlorophenyl)-1,1-dimethylurea) is a broad-spectrum residual herbicide widely utilised in Australian agriculture. It has been registered for use by the Australian Pesticides and Veterinary Medicines Authority (APVMA) for over 20 years. Known as a photosystem II herbicide (PSII), it disrupts a plant's ability to photosynthesize. Diuron is often used as a potency reference herbicide to assess effects on non-target species due to its effectiveness at low concentrations. Table 1 shows the relative potency of common PSII herbicides used in Australian agriculture (diuron, for example, is more than 10 times as potent as Atrazine).

The Australian Agricultural Chemical Usage Database, maintained by the federal Department of Environment, cites that between 2003 and 2006 (no public records exist in the database after 2006), more than 8394 tonnes of diuron was applied annually across the country (ACUB, 2013). The vast majority of the usage is in wheat (51%) and barley (21%) industries, with sugar representing the third highest usage amounts (6.5%).

In Queensland, the sugar industry represents almost 97% of diuron usage with just over 500 tonnes of diuron applied on average each year between 2003 and 2006. The vast majority of the Queensland sugar industry is within catchments that flow into the Great Barrier Reef (GBR). The dominant sugar growing regions are the Wet Tropics, Burdekin Dry Tropics and Mackay–Whitsunday NRM regions, all of which represent significant levels of risk to the GBR through their influence on water quality (Brodie et al., 2013).

Diuron is frequently detected in aquatic and marine water quality monitoring programs within the catchments and waters of the GBR (Shaw et al., 2010; Davis et al., 2012b; Kennedy et al., 2012; Lewis et al., 2012; Smith et al., 2012). It has also been implicated in negative environmental impacts on: seagrass (Haynes et al., 2000); mangroves (Duke et al., 2005; Duke, 2008); coral (Jones et al., 2003; Negri et al., 2005, 2011); foraminifera (van Dam et al., 2012b) and benthic microalgae (Magnusson et al., 2008, 2012).

Diuron is a herbicide with a relatively long soil half-life of 75 days; field trials however, report a range from 20 to 231 days (Hertfordshire, 2013). The combination of potency and longevity, raised concerns that diuron was having a negative effect on the marine environment of the GBR. These concerns contributed to the registration of diuron being reviewed by the APVMA in 2002. The review was completed in November 2012. This report examines the findings of the review and highlights the deficiencies in the assessment that the APVMA based its review decision on. This examination of the review is based only on information that was available to the APVMA prior to the completion of the diuron review.

2. APVMA review

The APVMA review process began in 2002 and was finalised in November 2012 following an environmental risk assessment of diuron use across all relevant agricultural sectors and other relevant users. According to Section 34(1)(a) (iii) of the Agricultural

* Tel.: +61 (0)419 791532.
E-mail address: g.holmes@uq.edu.au

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Table 1
Relative potency of common PSII herbicides from Magnusson et al., 2010.

PSII Herbicide	Relative potency
Diuron	1
Tebuthiuron	0.08
Atrazine	0.09
Simazine	0.03
Hexazinone	0.66

and Veterinary Chemicals Code, to allow the continued use of an agricultural chemical the APVMA must be satisfied that its use "*would not be likely to have an unintended effect that is harmful to animals, plants or things or to the environment*". The dominant concern with diuron was that it posed a risk for aquatic organisms.

The final APVMA decision was based on a technical assessment provided by the Federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). DSEWPaC in turn sub-contracted out the assessment to a third party specialising in environmental risk (pers. comm. S. Pike APVMA). It is acknowledged that the technical assessment was conducted by DSEWPaC and its sub-consultant. Therefore, throughout this report, references to decisions made by the APVMA inherently include DSEWPaC and its sub-consultant.

The level of environmental risk associated with the application of diuron (as with any other agricultural pesticide) was determined using an approach based on the methodology outlined in the Agricultural Manual of Requirements and Guidelines (AgMORAG). The AgMORAG methodology is a modelling approach developed by DSEWPaC combining an OECD model, REXTOX (OECD, 2000) which determines the amount of pesticide lost from a field, and a model that determines the corresponding concentrations in adjacent waterways (Probst et al., 2005). The environmental risk is deemed as acceptable if the predicted concentration in waterways is below a pre-determined ecotoxicological endpoint.

The OECD model (REXTOX) was developed as one of three aquatic risk indicator tools for use "by OECD governments to assess progress in risk reduction" (OECD, 2000). The model was developed in the European agriculture setting and field tested by OECD member states (Switzerland, Norway, Japan, Denmark, France and Germany). It does not appear to have been tested in tropical environments. This model determines the percentage of applied pesticide that is lost to runoff three days after application. It does not predict associated waterway concentrations.

An extension of the REXTOX model created by Probst et al. (2005) determines associated waterway pesticide concentrations. This model was also developed and validated in Germany in the same location as the REXTOX model.

The DSEWPaC runoff model as described in AgMORAG has a three tiered approach to determining the risk from runoff. The first tier is a very "broad brush" screening assessment. The second tier provides a more in depth analysis considering parameters such as soil properties and chemical degradation and provides an "edge-of-field" concentration. The final tier calculates the corresponding concentration in a standard water body (1Ha, 15 cm deep).

The methodology used for assessing the risk posed by diuron was a more refined approach than that outlined in AgMORAG. Again, using a three tiered approach, the first level assessed the concentrations in a standard water body. The second level assessed the risk of a rainfall event causing runoff that would result in unacceptable concentrations. The final tier calculated the resulting in-stream concentrations based on the approach of Probst et al. (2005).

The final decision on diuron use in the sugar industry has resulted in a complex set of region specific label instructions. Restrictions apply to the maximum application rate in the Wet Tropics and during the wet season in other regions, but allows for the use outside these regions and times at the same maximum rates as already regulated under Queensland's Great Barrier Reef Protection Amendment Act (2009). Diuron can only be applied once per calendar year at a maximum rate of 1.8 kg of active constituent per hectare (kg ac/ha). In the Wet Tropics and during the wet season in other regions, the maximum application rate is 450 g ac/ha. Refer to APVMA (2012) for full details of the label restrictions.

3. Problems with the technical basis for the APVMA decision

Through the iterative review process over the 10 years that diuron has been under review the APVMA has had to respond to many criticisms on various technical aspects. There remain however, several key issues with the approach taken by the APVMA, particularly in regards to the application of the risk assessment methodology to tropical crops such as sugar cane. These include:

- the use of the DSEWPaC runoff model outside its valid bounds;
- poor validation of modelling results;
- deviation from the base procedures and assumptions;
- application of the model results to irrigated farming; and
- the toxicity endpoint used to assess risk.

3.1. The DSEWPaC runoff model and tropical crops

The OECD REXTOX model that forms the basis for the DSEWPaC model has limitations in the parameters for which it has been validated. These include the levels of rainfall for which it can estimate the amount of runoff and its ability to account for different soil types. While these limitations may not be problematic for a large range of agricultural crops and regions, they do become problematic when applying the DSEWPaC model to tropical crops such as sugarcane.

3.1.1. Rainfall

The OECD REXTOX model (OECD, 2000) estimates the proportion of rainfall that contributes to runoff from a series of look-up tables originally developed for a German agricultural setting. These tables provide runoff values for two soil types (sand and loam) with rainfall up to 100 mm per day. While this may be sufficient in European agricultural regions, it is insufficient for tropical regions where daily rainfall in excess of 100 mm is common. This is evident from the rainfall data used by the APVMA in their assessment for each sugar growing region (Table 2). The rainfall data demonstrates that with the exception of the Burnett–Mary, in each region there is likely to be rainfall outside the bounds of this model.

The use of a 100 mm rain event by the APVMA in the Tier 1 assessment is also unusual as OECD (2000) recommends a default rate of 30 mm per day. Coincidently, a 30 mm rain event also corresponds to the maximum concentration in the standard water body calculated in the APVMA assessment as shown in Fig. 1.

Table 2
Rainfall data used in APVMA assessment (APVMA, 2012).

Sugar Region	90th Percentile 1 in 1 year 24 h rainfall (mm)
Wet Tropics	210
Burdekin	149
Mackay–Whitsunday	155
Burnett-Mary	103
NSW	132